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THE TECH ENGINEERING NEWS

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

VOL. IV. NO. 4

OCTOBER, 1923

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VOL. IV. NO. 4

OCTOBER, 1923

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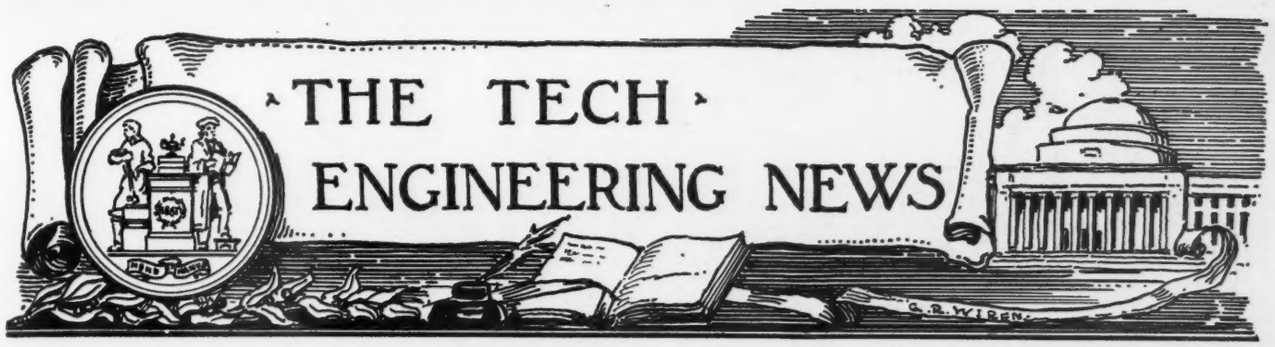

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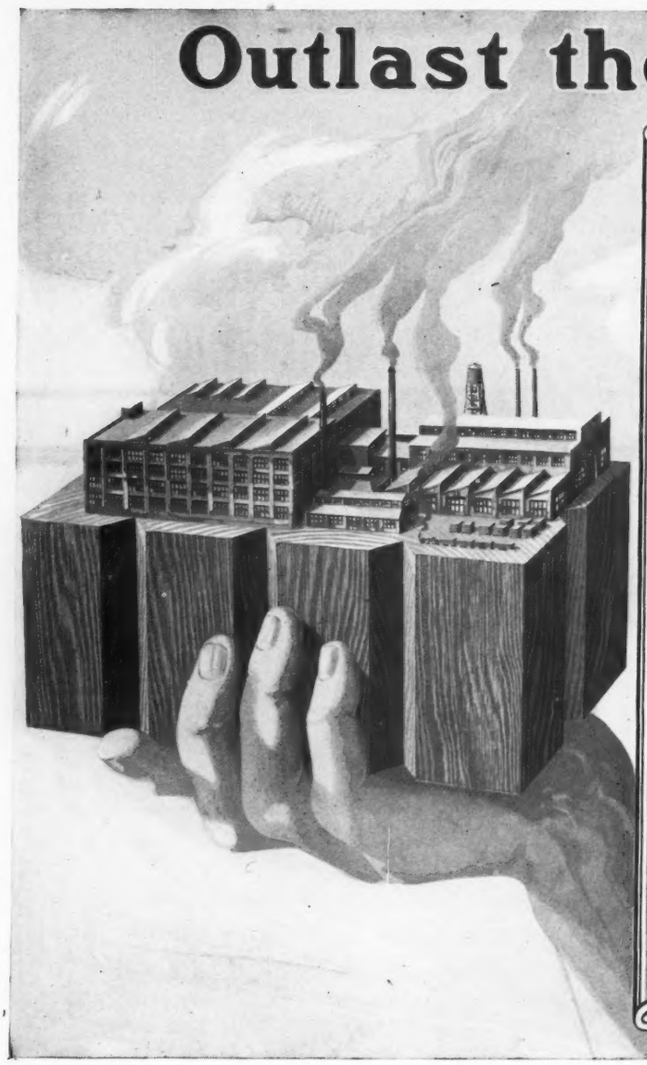

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE ALUMNI AND UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME IV | OCTOBER, 1923 | NUMBER 4

HIS MAJESTY, THE ENGINEER

Thinking men are concerned with the future welfare of the human race. They are not only interested in the affairs of today and the things which affect them during their own lifetime, but they are also concerned with the things which have to do with the upbuilding of their community, the progress of their own countries, and the greater movements which affect the world at large.

It is fascinating and enlightening to study from such records as are available the progress and evolution in prehistoric times and also to study the progress of the human race since the dawn of history. With the advent of the printing art a condition was achieved where nothing can wipe out our records and take from us or the future generations the knowledge of progress in all the arts and sciences which go to make for human comfort and happiness

We who are living and working with the men of our century in the great industrial beehives of our country are constantly reminded of the colossal imagination, tireless energy and infinite patience of the vast army of men who have contributed so much in the never-ending conflict with nature and her secrets and who have done so much to make the world a better place in which to live.

It is controversial whether or not this era will be known in the future as the engineering or the electrical age. Regardless of opinion on the subject, we who have contact in both activities are inclined to the belief that the oft questioned egg was originally sponsored by a hen and for that reason are influenced to the belief that the Electrical Age must necessarily follow the splendid accomplishments of the Engineering Age.

Edison, Bell, Marconi, Steinmetz, Kelvin, Thompson and Westinghouse are names long and intimately associated with science and things mechanical and electrical. The chroniclers and historians of the future will unquestionably write these names and hosts of others in large letters for their individual and collective contributions to the Engineering Age.

The engineer, as we know him, is not the anemic, long-haired genius who goes crystal gazing and therein conceives great things; neither is he the spectacular bronzed Apollo of the movies, but rather does he strongly resemble the average "white-collar guy," not afraid of dirt or smoke, who works equally well in his shop overalls or office coat, who theorizes, then cuts and tries — and tries and tries — who knows not fatigue, and whose genius has been correctly expressed as two per cent inspiration and ninety-eight per cent perspiration.

The Engineering Department of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa., has over seven hundred such men in its organization; other of their fellows who have been trained in this same office are the backbone of the sales organization of the Company and the sales policy is predicated on the engineering efficiency of their products. The very corporate character of the institution rests on the foundation of the engineering organization.

This organization comprises approximately 1860 employees of which 725 are engineers, 360 draftsmen, 125 tracers and 650 clerks. Engineering activities are divided into four major classes: Executive and Consulting; Research, Design and Application.

The growing need for trained men in these departments necessitated the development of a technical students' graduate course in order to meet the demand in a systematic manner. The Educational Department works in conjunction with the other department in training men and in placing them where they will have opportunities in accordance with their special abilities.

The roll of the Company's executives contains a liberal proportion of men who originally entered the employ of the organization directly from technical schools as graduate students. Candidates for the Graduate Student Course are selected upon the completion of their course by a representative of the Company after a searching interview and a thorough investigation of scholastic records; each candidate is given a rating as to his physical qualities, traits of leadership, personality, special talents and analytical ability; the course is usually about a year in duration and every effort is made during the first few months to discover the field of his greatest aptitude. To this end he is interviewed by representatives of several departments. He is put in full possession of information concerning the work of the various departments and of the company's policy and personnel. This process of segregation enables the educational department to determine the possibilities of the men along lines of design — application, commercial or works engineering. Thus men are trained for definite functions and at the conclusion of the course automatically become members of the personnel of the engineering department for which they have been trained.

With the Westinghouse Company, the only limitations the engineer has are his own. He is constantly encouraged to think along lines of improvement in design and application, and is substantially rewarded for accomplishment in this field. He has unlimited opportunity to utilize the shop equipment, scientific instruments, and above all, has the advantage of consultations with many of the best engineers this country has ever produced.

In all cases where a new theory is involved, the opportunity of making a practical test is given with money advanced for the purpose by the company. Here a man may make a model and demonstrate its workability.

Patents are applied for in the name

(Continued on page 148)

THE FOUNDERS OF THE INSTITUTE

By PROF. HARRY W. TYLER, PH.D., '84
Walker Professor of Mathematics, Massachusetts Institute of Technology

Historically, the founding of American Colleges has varied widely in circumstances and significance. Sometimes it has been an admirable method of devoting wealth to the commemoration of a family name, sometimes a worthy manifestation of state or civic resources, sometimes the conscious effort of a community to provide ample opportunities for the higher education of its youth.

In the case of the Institute of Technology, while the last of these causes was doubtless a contributory one, underlying it and much more potent was the inspired vision of one far-sighted man — Prof. William Barton Rogers. Born in 1804 when physics, chemistry and geology were beginning, but only beginning, to take on something of their modern aspect, he found it possible, as it has now become impossible, to attain mastery in all of them. With unusual breadth of intellectual sympathy he combined appreciation of the intrinsic dignity of science and of the coming dependence of public prosperity and welfare upon applications of it. At the same time no iconoclast, he had the personal charm and the linguistic and literary training necessary to preach his doctrine with natural and convincing eloquence to all sorts and conditions of men.

The time was ripe, the place well chosen. The United States after decades of strenuous pioneering had wrestled during four long years with a crucial problem which it had found no way to settle save with blood and iron. The immense energies developed in this desperate struggle were turned into peaceful channels. Large-scale industry, large-scale agriculture and transcontinental communication were beginning and all required trained men, not merely as leaders but as junior officers for the new armies of peace, far in excess of any available supply. The need was not indeed widely or quickly recognized. In Europe, France and Germany led in technical education; England lagged behind, trusting too much to her earlier development of the factory system. International expositions in Paris and London gradually but powerfully operated to open the eyes of men and nations to the possibilities of industry based on science. A few of the great European technical schools had been founded, or reorganized, in the latter half of the eighteenth century, but most of them were younger. Solid and deep as were their foundations, one and all were handicapped by undemocratic traditions of one sort or another. Higher education was for the favored few, not conceivably free for the intellectually capable, however humble their antecedents. Manual labor was to be performed by a social class predestined thereto. From such hampering traditions our country was fortunately free. Its own too abundant difficulties were of a different sort—the dominance of the classical tradition in education, the newness of the country and the consequent lack both of capital and of men not preoccupied in activities closer at hand, the sparseness of the scientific population. Under such handicaps the United States depended for its engineers on men of European training, on graduates of West Point or Annapolis turned civilians, or on those of Rensselaer, Union, the Sheffield and the Lawrence Scientific Schools — all eked out perhaps by some sort of an apprentice system following the English custom. Even in the darkest days of the Civil War, however, Congress so far recognized the urgency of radical improvement as to pass the historic Morrill Act of July 2, 1862, granting public lands under specified conditions to every state for the promotion of education in agriculture and the mechanic arts. Every state in the union has since shared in the benefits of this and subsequent legislation.

Rogers succeeded his father as professor of "natural philosophy" at the ancient college of William and Mary, in 1828, and was called to a similar chair in the larger University of Virginia in 1835. Each of these institutions had an honorable history. From the university especially, Rogers acquired experience and convictions invaluable for his future career. The university carefully planned by Thomas Jefferson, and opened but ten years earlier not far from his own home, had certain rather unique features: "Supported chiefly by the State, free from sectarian control, and open to all classes of the white population; governed on the part of the State by a Board of Visitors, and on the part of the instructors by the Faculty which was itself without a president and answerable only to this Board; located in buildings expressly designed as an historical architectural setting for a thoroughly modern establishment, and fearlessly discarding obsolete or obsolescent educational ideals." In 1844, Rogers was elected Chairman of the Faculty. As chief administrative officer of the university it devolved upon him not merely to carry on its ordinary administration but to expend much time and energy in disciplinary matters.

To the same period belong certain interesting and far more congenial

THE TECHNOLOGY SERIES

Last year THE TECH ENGINEERING NEWS published a series of articles on the buildings, laboratories and business administration of the New Technology. This series met with such widespread approval among our readers that we are continuing the idea this year. Our new series will be of a slightly different character, dealing with the great personalities and the more human side of the Institute. As our space limits us to only a bare outline of the subject, it is hoped that the new series will serve as an inspiration to further reading along this line. The topics which the series will cover are as follows:

THE FOUNDERS OF THE INSTITUTE .....October
Prof. H. W. Tyler, Head of the Department of Mathematics.

FRANCIS AMASA WALKER .....November
J. P. Munroe, Secretary of the Corporation, M. I. T.

RICHARD COCKBURN MACLAURIN ..... December
Author to be announced later.

A HISTORY OF THE SOCIETY OF ARTS .....January
Prof. H. M. Goodwin, Department of Physics.

A HISTORY OF THE DEPARTMENT OF ARCHITECTURE ....February
Author to be announced later.

A HISTORY OF THE DEAN'S OFFICE .....March
Author to be announced later.

RELATION OF INSTRUCTOR TO STUDENT AT TECHNOLOGY ..... April
Prof. L. M. Passano, Department of Mathematics.

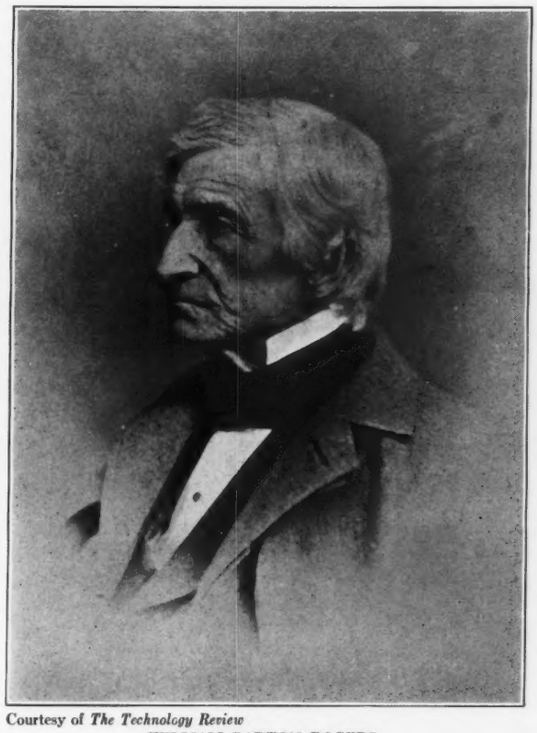
GREAT GATHERINGS AT TECHNOLOGY .....May
Author to be announced later.

activities, his public lectures on scientific subjects in Baltimore and elsewhere and his monumental geological survey of the State of Virginia — the most important piece of scientific work of his life.

To this period of middle age belongs also, the most important event of his life — his marriage in 1853 to Miss Emma Savage of Boston, followed on the same day by their departure for his first visit to Europe. Rogers had made several previous visits to Boston, attending scientific meetings in 1842 and later. In 1841 he writes: "Since my summer's rambles with Henry, I have been unable to shut out the contrast between the region in which I live and the highly cultivated nature and society of glorious New England. I have, therefore, felt less than usual the pleasure of returning to my home. I have been mortified and provoked, too, at finding so much illiberality among a portion of the community here on the subject of religion, as displayed in the bigoted publications which appeared during the summer respecting the appointments of Sylvester and Kraitzer. Would you believe it, that a series of essays has been published condemning the visitors for the appointment of a Jew and a Catholic, and sweeping charges at the same time made against the character, literary as well as moral, of the University!"

As his ideas in regard to a modernized education in science gradually took definite shape, he realized that in Massachusetts rather than Virginia would it be practicable to bring them to pass. To this still more formidable undertaking he devoted the remaining years of his life and in it he was most powerfully and effectively sustained by Mrs. Rogers. As so forcibly expressed by the most competent surviving witness of his generation, President Eliot, the Institute of Technology was founded by Professor and Mrs. Rogers.*

In 1846 Professor Rogers writes to his brother Henry — then in Boston — responding to an invitation to outline his views of the possible Polytechnic Institution which they had much at heart: "The true and only practicable object of a Polytechnic School is, as I conceive, the teaching, not of the manipulations and minute details of the arts, which can be done only in the workshop, but the inculcation of all the scientific principles which form the basis and explanation of them, and along with this a full and methodical review of all their leading processes and operations in connection with physical laws. When thus instructed in applied science, the mechanician, chemist or manufacturer, clearly comprehending the agencies of the materials and instruments with which he works, is saved from the disasters of blind experiment, guided securely because understandingly in a profitable routine, or directed to the contrivance of new and more efficient combinations. Were it necessary at this day to adduce proofs of these practical fruits of instruction in physical science, we might boldly refer to the unexampled progress of every branch of the arts for the last fifty years as but the result of the general diffusion of a better knowledge of physical laws, which has flowed from the researches of men especially devoted to natural science. Bearing in mind, too, how few in these times, are of real and permanent value, and how immense the number of utterly barren inventions, the labored contrivances of acute but undirected or misguided minds, we cannot but believe that, with a proper training in science, the host of unprofitable inventors living within the last half century would have contributed innumerable really valuable aids to human industry, and have advanced the arts to a stage of far higher improvement than they have attained. What stronger argument on this head could be asked than a glance at the encumbered cases of the Patent Office at Washington?"



Courtesy of *The Technology Review*
WILLIAM BARTON ROGERS

"Among practical pursuits there are perhaps none whose dependence upon the determinations of physical science is more generally recognized than those of the machinist, the engineers and the architects. Yet even in these professions, while all admit that many of the details are but immediate applications of the leading laws of mechanical philosophy, how few have formed a just conception of the variety and extent of the sciences they involve. In the first place, the materials used must be studied in their more important mechanical and chemical relations. The strength of beams of timber and metal of various shapes and dimensions, and placed in various attitudes in buildings or machinery, must be computed by formulae derived from scientific researches. The direction and energy of the forces distributed to different parts of the structure according to the arrangement of the several parts, and the position of the load or other pressure, require also to be known, and can only be learned by an appeal to the principles of mechanical science. So also, the durability of the materials employed in masonry can only be safely inferred from a knowledge of their composition, and the chemical actions to which they will be subjected when exposed to the air or water, or both, or when submitted, as in the walls of a furnace, to intense heat.

"The machinist should, moreover, clearly understand all the principles of equilibrium and of the composition of forces; in other words, the general doctrines of statics and dynamics, those of friction, whether sliding or rolling, the mode of operation of the various motive powers of which his mechanism is to be the conductor, and the methods of computing the relation between the force applied and the useful effect obtained, or, in other words, the economical value of the combination.

"The road engineer, with as ample knowledge in all these particulars, should further have a good acquaintance with the mineral and geological character of the region in which he operates, should know when to interpret the appearances on the surface, either as an encouragement or warning, in directing his tunnels or other

(*Continued on page 150*)

*The story of the foundation and of the early years of 1862 have fortunately been preserved in the LIFE AND LETTERS OF WILLIAM BARTON ROGERS, prepared by Mrs. Rogers and Professor Sedgwick — a mine of information which every good Tech man should find time to explore. From a different angle the salient features are reviewed in Munroe's recent LIFE OF FRANCIS AMASA WALKER, which to readers of the T.E.N. should need no commendation.

THE DEGLARESCOPE

By PROF. WILLIAM S. FRANKLIN and ELOF BENSON
Department of Physics, Massachusetts Institute of Technology

Prof. William J. Drisko of the Massachusetts Institute of Technology, Technical Adviser for the Massachusetts Highway Commission, gave recently a public lecture under the auspices of the Society of Arts. In this lecture Professor Drisko called attention to the problem of headlight control and demonstrated a variety of controllers and lenses. He called particular attention to the Deglarescope and he characterized this device as unique and ingenious in design and as highly effective in operation; and the interest which was called forth in this novel light controlling device by Professor Drisko's demonstration and description has led to the preparation of this paper.

The purpose of every headlight controller is two-fold. One of its functions is to give the best possible distribution of the headlight beam over the road and another equally important function is to eliminate the disagreeable and dangerous glare with which every one is familiar. These two functions are to some extent incompatible with each other in most of the existing headlight controllers, and the legal requirements or specifications have therefore been framed in a reasonable and practical spirit of compromise. Always, of course, the "state of an art" must to a very great extent determine the legal

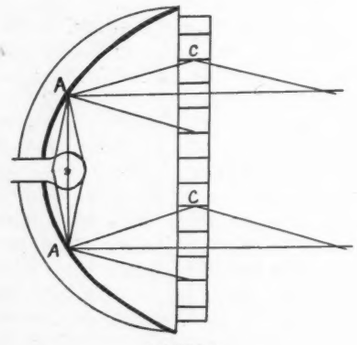


FIGURE 1

requirements which are to determine the practice of that art, and a corollary to this eminently practical proposition is that the legal requirements should be quickly responsive to improvements in the art.

The above mentioned incompatibility between the two important functions of a headlight controller is very greatly modified by the advent of the Deglarescope, and it is the purpose of this article, first to offer a constructive criticism of existing legal requirements in view of the improvement in the art of headlight control which is embodied in the Deglarescope; second to describe the Deglarescope and set forth the great increase of compatibility of its anti-glare and light-distributing functions.

Headlight glare can be eliminated only by cutting down the intensity of that portion of the headlight beam which enters the eyes of the driver

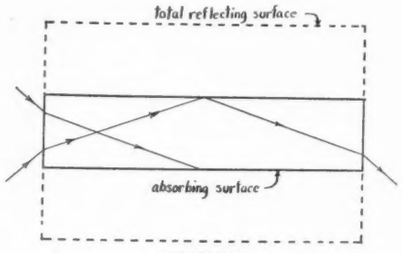


FIGURE 2

of an approaching and passing machine and the complete elimination of glare would mean the cutting down of this intensity to zero or nearly to zero. Assuming this to be possible (and the great virtue of the Deglarescope is this possibility), the legal requirements should be framed after careful consideration of the possible usefulness of the upper portions of the headlight beam (and again the virtue of the Deglarescope is that it can be designed to give any desired amount of light in the upper portions of the headlight beam). But what is the use of the light in the upper portions of the headlight beam? This is a complicated question and its best answer must come from a consideration of actual examples. The example most commonly used to show that the light in the upper portions of a headlight beam is useful is that of a driver who drove under a guyrope which was stretched across the road; the rope was invisible and the driver was killed. One might suppose that this accident would have been avoided if there had been a sufficient amount of light in the upper part of the headlight beam, but it must be admitted that an excessive amount of light would have been necessary, an amount altogether out of the question if excessive glare is to be eliminated. Another consideration which shows that there is a certain amount of usefulness of the light in the upper parts of a headlight beam is that any object on the road is more readily seen by a driver if he can see the whole of the object. Thus a complete man is more readily perceived than a half of a man! A man with head and legs is more quickly perceived than a man without a head! It must be admitted therefore that the light in the upper part of a headlight beam is in general useful; but the question remains as to how useful, for this light is certainly objectionable because it produces dangerous glare. This question is again a complex question and the legal specifications which grow out of it must be matters of compromise. We are of the opinion that the usefulness of the light in the upper part of a headlight beam is of secondary importance as compared with the necessity of eliminating glare, and we therefore advocate legal specifications which allow a very low maximum amount of light in the upper part of a headlight beam, and we advocate the omission of any specified minimum amount of lighting in the upper part of a headlight beam. In deciding upon the legal specifications as to the maximum permissible amount of light in the upper parts of a headlight beam it is important to keep in mind a condition which exists on the road but which is absent in the testing laboratory. Even if there were no light in the upper parts of the headlight beam itself, there would be a very considerable amount of light thrown upwards from the illuminated portions of the road.

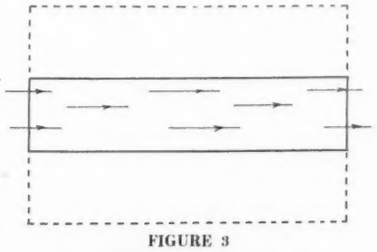


FIGURE 3

We are frankly discussing legal specifications from the point of view of our interest in the Deglarescope, or, to put the matter more fairly, we were led to the design of the Deglarescope because of our unbiased judgment as to the paramount importance of eliminating glare, and but one point remains to be discussed, namely, the permissible candle-power in the headlight lamp. In matters of side spread and road illumination in general the Deglarescope does not differ from other forms of headlight controller, but

(*Continued on page 154*)

SCULPTURE BY PHOTOGRAPHY

By HOWARD M. EDMUNDS
Parliament Mansions, London, England

The process of photographing in three dimensions which has been developed by the writer can be most readily understood by using as a starting point the analogy to surveying.

As all measurements in plan in a survey are ultimately referred to some base line of known length, so in this process of Photo-Sculpture a base

SIDE FACE PORTRAIT

plane is used to which the elevation of all points on the irregular surface are referred.

The process can be divided in two parts—the optical and the mechanical. The apparatus for the optical part consists of a projector and one or two cameras. In the projector is placed a sheet of plate glass having engraved upon its surface a series of fine parallel straight lines. These lines are spaced one hundred fifty to the inch and are normally positioned with the lines running vertically. With the use of a powerful arc lamp and a condenser the image of this grid is focused at a distance of approximately ten feet from the projector lens. We must now consider what will happen if some solid object is placed at the point of focus. It will be evident that the lines will appear distorted when viewed from any position other than that occupied by the projector lens itself. It is upon the distortion produced in the lines when viewed by the camera that one depends to obtain a record from which the subsequent carving can be made.

A study of the laws which govern the distortion reveals the following facts. If the camera lens is placed in a plane normal to the axis of the projector lens and such plane passes through the optical center (Gauss point) of the projector lens, then, provided the plate in such camera is in a plane parallel to the grid in the projector, the distortions in the lines will conform to the following laws.

First, consider the line projected on a plane surface normal to the lens axis of the projector, and then upon an irregular solid object. If we do this, then:

(1) The amount of distortion for points on the solid object which are the same distance from the plane surface will be equal.

(2) The directions of displacement of all points will be parallel to each other.

If now we place two cameras at equal distances and on opposite sides of the projector in a horizontal plane and place the grid so that the lines in it are vertical, we shall be able to get records of any solid object from which we can afterwards make a carving. That is to say, we have obtained a two-dimensional record of a three-dimensional object in which the third dimension is as if it were folded over into the plane of the other two. In other words we have drawn photographically a series of parallel sections of the object which are close enough together to give a rendering of the form.

The mechanical process of carving from these photographic records which have been called "Contourographs" can be understood from the picture of the carving machine shown in the illustration.

Broadly, this machine works by cutting a series of furrows which are straight and parallel in plan but which follow in elevation the undulations indicated by the photograph record.

The machine has a drill and a microscope attached whose movements are at right angles to each other and both are actuated by a hand operated worm and wheel. The ratio of movement can be changed mechanically so that the degree of relief can be altered at will.

For side face portraits a flat relief is suitable. This is illustrated in the cut of Pirie MacDonald. For full faces the degree of relief can be increased up to the full (round) as is shown in the full face portrait of a lady.

A more detailed explanation of the technical side of the process is scarcely possible within the limits of this contribution, but I would be glad to provide it if wanted.

The fact that photography may be made use of to produce sculptured or carved replicas of solid objects has aroused considerable interest, speculation and comment as to what may be the consequence of such a development.

(*Continued on page 144*)

THE CARVING MACHINE

This machine produces Contourographs from photographic records

CULTURAL COURSES

By PROF. MELVILLE ENGER
Professor of Mechanics and Hydraulics, University of Illinois

Culture is a composite of a number of desirable attributes. We think of a cultured man as having a keen, well-balanced, inquiring, tolerant mind, broad interests and a large fund of information, an active, sympathetic interest in his fellowmen, polished manners, and as being a good conversationalist and writer. The atmosphere of the college, both in and out of the class room, should be favorable for the development of culture. Emerson says, "Every man, in the degree in which he has wit and culture, finds his curiosity inflamed concerning the modes of living and thinking of other men, and especially of those classes whose minds have not been subdued by the drill of school education. This instructive action never ceases in a healthy mind, but becomes richer and more frequent in its informations through all states of culture. At last comes the era of reflection, when we not only observe, but take pains to observe; when we of set purpose sit down to consider an abstract truth; when we keep our mind's eye open whilst we converse, whilst we read, whilst we act, intent to learn the secret of some class of facts. . . . Truth is our element of life, yet if a man fasten his attention on a single aspect of truth and apply himself to that alone, the truth becomes distorted and not itself but falsehood. . . . How wearisome the grammarian, the phrenologist, the political or religious fanatic, or indeed any mortal whose balance is lost by the exaggeration of a single topic."

The difficulty in making technical courses of cultural value to the engineering student lies in the fact that attention is too much directed on one class of facts. There is no truth in the assumption that technical courses are inherently non-cultural; on the contrary technical courses should be the basis for an important part of the engineer's culture. It is only by long continued specialization, which restricts intellectual curiosity to a small field, that technical courses become non-cultural. There is as much culture in algebra as in Latin grammar; probably no so-called cultural course increases the accuracy of thinking as does geometry. Bridge design, alternating current theory and thermodynamics contain the elements of culture, and when presented by teachers having broad interests may be cultural in a high degree.

But when all has been said that can be said for the cultural value of technical courses, it must be admitted that the curricula of engineering should include courses outside of the engineering field to keep them from becoming too one-sided. Non-technical courses having no direct relation to the student's specialty are the most valuable because it is important to broaden his range of interest. Advanced courses in mathematics and chemistry are therefore not suitable, although they are often elected by the student for their technical value.

> *To civilize the rude unpolish'd world*
> *And lay it under the restraint of laws,*
> *To make men mild and sociable to man,*
> *To cultivate the wild licentious savage*
> *With wisdom, discipline, and lib'ral arts,—*
> *Th' embellishments of life! Virtues like these*
> *Make human nature shine.*
>
> — *Addison.*

Education does not end with graduation from college. It is a process which continues throughout life. Success depends largely upon the capacity for growth and development after graduation. It should be the aim of the college to develop ideals, to awaken intellectual curiosity, and to make the student capable of efficient self-instruction. The acquisition of facts is important. There is a certain minimum of knowledge which every educated man should have, but much of the information which forms a large part of some technical courses is not important enough to justify the effort and time to acquire it. Most of the facts learned in college will be forgotten in ten or fifteen years. There may be truth in the statement that "the culture which is in a course is that which remains when all of the facts have been forgotten."

The lack of fluency of the average engineering graduate is a deficiency in culture for which engineering teachers must assume some of the blame. Too little attention is given to methods of presentation. Carelessly worded recitations and mediocre reports are accepted if the right idea is implied. Engineering reports and specifications require accuracy and clearness in the same degree as engineering drawings. The lack of fluency is one reason for the unsatisfactory position of the engineer in society because on questions of public interest the engineer usually remains silent while others less well qualified assume leadership.

Economics, history, literature and languages are among the subjects usually recommended as cultural subjects, and there can be no question as to their value to engineering students when properly presented. The value of non-technical courses for the engineering student is measured by the interest aroused. A course in literature should develop a taste for good reading. Courses in history or economics should stimulate the student to self-directed study in these fields.

Cultural courses are needed for the full development of the engineer, not because they contain "culture" in a greater degree than the technical courses, but because they are complementary to the technical courses. The liberal arts student for the same reason needs technical courses to promote his culture. The curricula in engineering should be so arranged that the student's interests are aroused in a wide field because this will promote the progress of his education after graduation. It is not desirable to sacrifice depth for breadth in the major technical work, but it is necessary to do so in the other courses. If the college course has been a success, deepening and broadening will continue after graduation.

Finds Aluminum Paint Makes Radiators Less Efficient. The aluminum or bronze paint generally applied to radiators greatly reduces their effectiveness and makes it necessary to have a larger surface for the same heating effect, according to experiments performed by Dr. W. W. Coblentz of the Bureau of Standards. Doctor Coblentz finds that the heat radiated from an aluminum painted radiator surface is less than a third of that emitted by a radiator of the same size painted with a non-metallic paint, enameled, or simply allowed to rust.

On the other hand he finds that aluminum paint is a very effective means of reducing the amount of heat transmitted through a thin material. Applied to the under side of a tent or awning it reduces by three-fourths the amount of heat from the sun which gets through the cloth, while if used on the cover of an automobile or ice wagon it cuts in half the heat let through and makes the temperature inside the vehicle more nearly that found in natural shade, thereby making it much more comfortable.

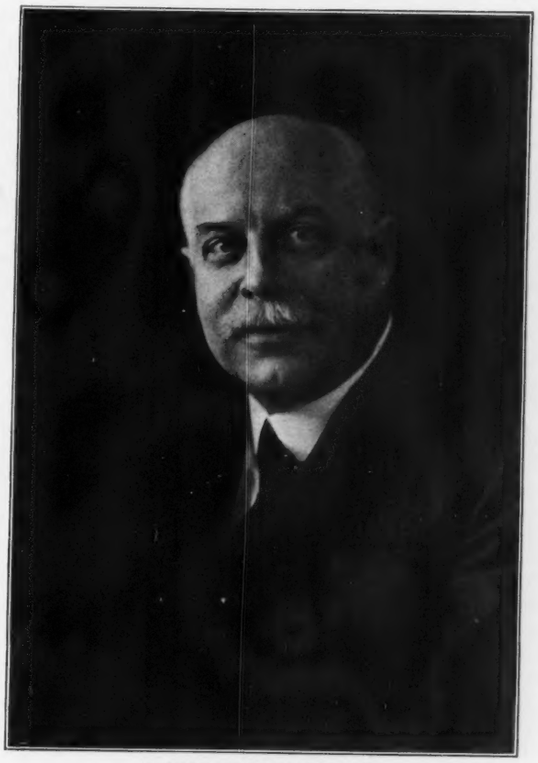
GEORGE K. BURGESS

By JOHN R. FREEMAN, JR., '16

Physicist, United States Bureau of Standards, Washington, D. C.

On April 21, 1923, Dr. George K. Burgess of the Class of 1896 was appointed by President Harding to be Director of the Bureau of Standards, succeeding Dr. Samuel W. Stratton, who had resigned to become president of the Institute; thus Technology, while calling Doctor Stratton away from the Bureau, was ready to furnish from among her alumni one who is eminently qualified to assume the directorship of the world's foremost scientific institution.

Doctor Burgess was born at Newton, Massachusetts, in 1874 and comes from colonial New England ancestry. His early education was obtained in the public schools of Newton from which he entered the Institute and graduated in 1896 with the degree of Bachelor of Science. After graduation he returned as an Assistant Physicist and Fellow of the staff of the Institute. From 1898 to 1900 he pursued advance scientific courses at the University of Paris where he received the degree of Doctor of Science with *mention très honorable* (the highest commendation given with the doctor's degree). Since his graduation Doctor Burgess has been an incessant student of the physical sciences, specializing in physics and technology, with special emphasis on the applications of science to industry, particularly in the field of metallurgy.



GEORGE KIMBALL BURGESS

After his return from Paris Doctor Burgess served on the faculty of the University of Michigan as instructor in physics and later accepted a similar post on the scientific staff of the University of California.

Doctor Burgess was one of the first to enter the service of the Bureau of Standards when appointed to its scientific staff as Assistant Physicist in July, 1903 and during his first years at the Bureau of Standards his notable work on pyrometry laid the scientific foundations for the now wide-spread application of high temperature measurements to American industry.

On July 1, 1913, Doctor Burgess was appointed chief of the Division of Metallurgy of the Bureau of Standards. This new division was organized by Doctor Burgess in a most thoroughgoing manner. His organization outline and research program were models of scientific research organization. Under his leadership the Division of Metallurgy became a highly efficient specialized organization with a staff of over fifty experts. For his exhibit of the work of the division Doctor Burgess personally received the silver medal and the Bureau of Standards received the gold medal from the Panama-Pacific Exposition of 1915.

For these and other meritorious services he was, on December 21, 1921, appointed Chief Physicist of the Bureau of Standards, the highest post on the scientific staff of the Bureau. In recommending this appointment the then Director of the Bureau of Standards wrote to the Secretary of Commerce:

> "Dr. Burgess is unquestionably in the first rank of metallurgists of this country. His work in this field in connection with military departments during the war and in connection with the particular industries for the past ten years fully warrant this small recognition of his service. Dr. Burgess has several times refused offers of far greater salaries from industrial organizations, feeling that he could be of much greater service to industry as a whole by remaining at work here on their fundamental problems."

Doctor Burgess has conducted the metallurgical work of the Bureau with notable success with a staff of closely coöperating specialists covering broadly the field of metallurgical work ranging from the melting and casting of metals through the mechanical working and heat-treatment to the microscopical, physical and mechanical testing. Doctor Burgess early appreciated the fact that if the fundamental properties of any metal or alloy were to be accurately determined and known the complete metallurgical history of the material must be known. Appreciating this fact, he showed keen foresight in installing in the Division of Metallurgy equipment which provides for all metallurgical processes from the foundry to the finished product, including a quarter-ton steel melting furnace, complete rolling mill, draw bench and forging equipment. Alongside of this process equipment were installed exceptionally well equipped laboratories for the study of the thermal, microscopic, physical and mechanical properties of metals and alloys. Doctor Burgess has always emphasized the importance in the study of the properties of metals and alloys of starting with pure metals and one of the most important pieces of work of the Metallurgical Division is the preparation of pure metals and alloys. The metallurgical laboratory of the Bureau of Standards is in fact unique among metallurgical laboratories of the world especially in covering the range from pure science to the most practical applications of metallurgical technology.

Doctor Burgess has always been especially successful in the effective contacts which he has maintained with all government departments and particularly with the industries and the technicians concerned with metal problems. As an aid in promoting such contacts there was developed a systematic series of conferences of experts on the various phases of metallurgical research. At these conferences important technical questions are discussed and conclusions embodied in working programs on which the various groups coöperate. These contacts established the metallurgical division of the Bureau as a smoothly functioning contributor to metallurgical progress.

(Continued on page 146)

GRAVEL ROAD MAINTENANCE

By F. D. COPPOCK

President, The Greenville Gravel Company

The last decade marks an epoch in our national progress. It has been difficult to keep pace with its succession of rapid changes. Radio and the aeroplane are mystic in their character and revolutionary in their application and yet no single innovation has so completely revolutionized our mode of living as has the motor driven vehicle.

The motor vehicle has brought with it serious problems. The tremendous increase in traffic on our highways makes it imperative that consideration be given to new methods and new economies in road planning, construction and maintenance. Coupled with the increased tourist traffic is the problem of motorized central schools, motorized mail delivery, motorized bus-lines, motorized parcel post delivery and motorized trucking, — the latter grown to such an extent as to bankrupt steam and electric lines — changes that have come so swiftly that we have been unable to put our highways in condition fast enough to care for the increased burdens. There is no reason, however, why we cannot readily adjust ourselves to the new condition and instead of our roads getting worse each season they may, by proper maintenance, be made day by day in every way better and better. Much criticism has appeared in magazines in recent months complaining about the deplorable condition of our highways, but little has been said in a constructive way. This article is prompted by a sincere desire to help solve in a practical way a vexing problem, irrespective of personal interest. It is intended to convey a practical plan for gravel road maintenance and impart an idea of costs and results. It is not for the purpose of opposing the construction of the various types. Permanent road construction is necessary, considering the present road traffic. Our object is not to discourage the building of permanent highways, but to encourage economy, and prove that there is a place for gravel in proper maintenance and construction of highways. Proper specifications should be exacted and proper maintenance methods employed in a practical and economical way to the end that we may quickly place our highways in condition to carry the increased burdens of present-day and future motor traffic.

In order to demonstrate to county officials the results and economies to be attained from intensive maintenance and full-time patrol, we took over, with the consent of the commissioners of Darke County, Ohio, about seven miles of one of the principal highways of the county and have for the past two years maintained the same under what we consider a proper and practical patrol method. Our experience in maintaining this road, together with our careful observation of maintenance on gravel roads in Indiana and Michigan, has placed us in a position to advance suggestions and offer some figures on the costs of such maintenance. We found that we attained results at the end of the first year which we had not hoped to reach before the end of two or three years. In fact during the thawing season of the first spring the road for its full width was in condition to carry automobile and truck travel without hindrance to the traffic or damage to the road.

The common fault with the old method of road repair is that after the materials have been placed on the road they are left as deposited for the traffic to pack and, as traffic follows only the packed wheel tracks, ruts are created which in wet weather will hold water until it soaks away. This water softens the material on the road and also the sub-grade so that traffic mashes the gravel down, mixing it with the dirt below, causing chuck holes and ruining the road. It is necessary to prevent ruts or depressions which hold water, and this can only be done by dragging often, and by the proper use of the right kind of surface materials.

Most of the old gravel roads have been built from gravel found in local deposits and while they do not as a rule need rebuilding, they do need a different kind of maintenance. Most of these roads have sufficient material on them so that if the proper drainage was provided and proper forming of the road's surface had, very little repair material would be needed to keep them in good condition. The success of gravel road maintenance depends more on the proper drainage and dragging than on the amount of material used.

The common practice of applying gravel in road repair is to dump a full load of gravel in a place, and often one load against another for a considerable distance. This practice is not only wasteful but, considering the present automobile traffic, dangerous as well. It is absurd to place thick layers of gravel on the road and expect it to be packed uniformly by the traffic.

The first step — and one of the most important things in the proper maintenance of gravel roads — is drainage. Today the side ditches of our older gravel roads are filled with material washed into them from the fields and from the road's surface, until in most instances there is no ditch or drainage. These ditches should be cleaned out and opened up until there is no point in them less than eighteen inches below the surface of the road. These side ditches should always have outlets to waterways leading from the right-of-way of the road. There should be no pockets or low places in the side ditches which will hold water.

Quite a few of the gravel roads have a sod berm along the edge of the road which is from two to three inches higher than the road's surface. This has been caused by the use of the road scraper. These shoulders are very detrimental and should be done away with, as they prevent the prompt flow of water from the road surface.

Because of the lack of side ditch drainage it has become common practice to ridge the gravel in the center of the road or maintain a very high crown. This was found necessary in order to drain off the water, and form a firm dry portion on which to drive. A high crown is detrimental as it causes all the travel to drive in center of the road, confining the wear to two narrow wheel tracks. The travel should be general over all parts of the road.

After proper drainage has been provided, the surface of the road should be lightly scarified or harrowed and dragged, so as to produce a uniform and smooth surface. This can be done without hindrance to the traffic. The crown or high center of the road can be loosened a little at a time by means of harrowing and this loose material moved with a drag to the side of the road and used to fill the low part of the road between the sod berm, or edge of the road, and the center.

This harrowing and dragging should be continued until the center of the road is not more than three inches or four inches higher than its edges. After this has been done and proper drainage provided, the road is then ready for surface treatment.

Next in importance to drainage and the proper preparation of the road bed, is the character of the material which is placed on the road. Present

day traffic requires a different material than formerly. Experience has already taught engineers and those boards and officers having charge of road maintenance that the old methods are inadequate and impractical. The past two years have clearly demonstrated the imperative need of not only adequate drainage and good road beds but of high class material in order to avoid the almost impassable road conditions that we have had during the thawing season of the past few years.

The average bank-run or pit-run gravel, as found in local deposits and commonly used, has proved unfit for use in road maintenance. These deposits do not run uniform in coarseness or quality. Very often they contain too much sand; always too much loam; and at times too many boulders.

Sand and loam create dust, prevent drainage, and retain moisture. In thawing seasons dirty gravel becomes very soft because of the moisture it retains. The old idea, that repair gravel should be mixed with loam in order to make it pack quickly, is an erroneous one. Repair gravel should have no loam whatever in it. Clean gravel will pack without hindrance to traffic if properly applied and maintained.

Boulders or large stones are very objectionable, as they are inclined to work to the surface, causing an expense to remove and also creating bumps which in turn cause chucks.

In road construction the gravel used should be clean and uniform in its mixture of various sizes from sand to pebbles not larger than one and one-half inches. At least twenty-five per cent but not to exceed thirty-five per cent of fine sand, one-tenth inch down, should be mixed with the gravel for road construction. A proper sand mixture prevents the sub-soil from coming up through the gravel, which is apt to happen under heavy traffic; at the same time an excess of sand is undesirable. Where a partial rebuilding is needed, or where the road is so nearly worn out that a light surface treatment is not sufficient, a clean gravel should be used, ranging in size from sand to one and one-half inches.

For maintaining the average gravel road the material should be that of a very fine clean gravel without sand. A washed and screened pebble ranging in size from one-tenth inch to one-quarter inch has proven satisfactory; a pebble from one-tenth to one-half inch is preferred, however. A pebble larger than three-quarters inch is never used. These should be applied in very thin layers as required. Each application should be a little more than enough to absorb all the worn-out particles or mud and soil on the surface of the road. There should at all times be a loose thin coating of this material on the road surface. Dragging the road will remove this loose material, filling in the low places as they occur and keeping the road smooth at all times.

The reason why a fine gravel is better than coarser material for road dressing or surface use is that if larger particles are used the process of dragging will pull the larger stones loose from the surface, making it rough and impossible to keep smooth.

An application of one inch of fine gravel twice during a season will keep a much used gravel road in excellent condition. This requires four hundred cubic yards of material per mile. The average gravel road can be well maintained with one application per season or two hundred cubic yards of material per mile. Roads which are used very little require still less.

The average cost of paved roads, concrete for example, is about twenty-five thousand dollars per mile, the interest on which at six per cent amounts to one thousand five hundred dollars per mile per year. Until the travel becomes heavy, a much used road can be maintained by the proper use of gravel and patrolling at a less cost than the interest on the permanent type.

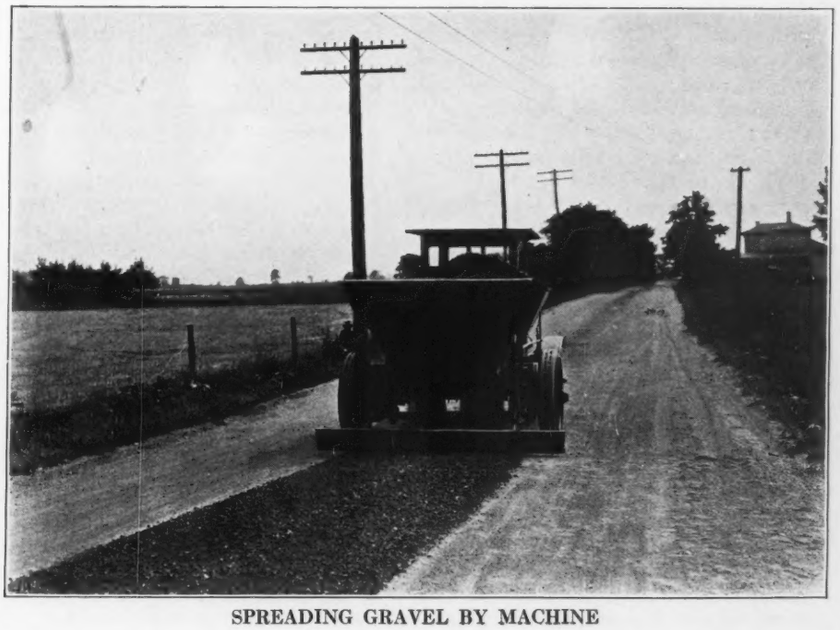
Roads so maintained will give good service during all seasons of the year at a very low cost. Compared with the so-called permanent type, a properly maintained gravel road is as smooth to ride over and as enjoyable, and until the travel becomes moderately heavy, it may be kept in every way as serviceable.

As to the cost of proper maintenance. The side ditches of the average gravel road can be cleaned out so as to provide good drainage at a cost of approximately two hundred and fifty dollars per mile. The other costs depend very materially on the amount of traffic. If the traffic is heavy, the material and labor costs amount to from six hundred dollars to eight hundred dollars per mile per year. If the traffic is medium this cost is about four hundred dollars per year. Byroads or gravel roads which are used very little can be maintained in good condition at a cost of one hundred dollars or less per year.

In order to properly maintain gravel roads, there should be constant employment. A certain number of miles should be placed in charge of one man, employed by the year. He should be provided with a light truck to be used for the distribution of materials, for hauling of refuse, and as a power unit for scarifying, harrowing and dragging of the road's surface. The general impression is that dragging should be done when the road is soft or after a rain or thaw. It is as important to drag the road in dry weather as in wet. In fact, a road under ordinary traffic should be dragged at least once if not twice each week, during the entire year. Under extremely heavy traffic it should be dragged each day.

One man can distribute the material, do the dragging, and properly maintain ten miles of gravel road under heavy traffic, after the drainage has been provided. Where the travel

(Continued on page 154)



SPREADING GRAVEL BY MACHINE

COLLOIDAL CHEMISTRY

By HARRY N. HOLMES

Chairman, Colloid Committee of the National Research Council

There is nothing mysterious about colloids. They are not new substances but merely ordinary substances with particles of special dimensions, ranging from approximately one to one hundred millionths of a millimeter. Such particles are a little larger than the largest molecules and yet just too small to be seen with definite diameter by the microscope.

Colloidal particles, then, are simply aggregates of a few hundred (more or less) molecules. With a somewhat greater degree of dispersion colloidal suspensions become true solutions. On the other hand, when these colloidal units or aggregates coalesce into still larger aggregates, they may be precipitated from suspension. Unless such coagulated material becomes distinctly crystalline on standing, we are in the habit of calling it colloidal, as in the case of cheese, for example.

From the theoretical standpoint, the chemist is interested in such topics as the preparation of colloids, their electric charge, coagulation, peptization, protective action, dialysis and diffusion, gel structure, surface tension, emulsions, viscosity, adsorption of gases, adsorption from solution and many others.

All the sciences, even astronomy dealing with the colloidal dust of comets' tails, are dependent upon colloid chemistry for their full development. Physics with its surface energy problems, geology with diffusion through gelatinous silicic acid and fine powders, biology with hydrated plant and animal tissues, medicine with the study of hydration and diffusion in body tissues and peptization by digestive juices, engineering with countless colloid problems to solve — all eagerly watch the rapid growth of the young science of colloid chemistry.

The applications to the industries are almost universal, although all manufacturers are not yet familiar with this fact. When research chemists demonstrate convincingly to their employers the basic connection between colloid chemistry and industry, our manufacturer will finally come to a proper appreciation of the financial importance of this growing science.

Colloid chemistry is closely related to the problems of lubrication, agriculture, de-watering oils, purifying clays, catching offensive or wasted fumes, drying peat, de-inking old newspapers, concentrating ores, tanning, baking, cooking, washing, dyeing, road-making, photography, water purification, sewage disposal; and one should know a good deal about colloid chemistry if he is to manufacture rubber goods, glass, porcelain, enamels, cements, alloys, fungicides and insecticides, dairy products, any cellulose ester materials, colloidal fuel, gelatine, glues, gas masks, adsorbent gels, paints, varnishes, soap, inks, oils, pencils and crayons.

Theory and practice must go hand in hand. For example, wetting power, the ability of a liquid to wet a solid, is a property made use of in many technical processes and one may blunder along in the application without adequate theory as a foundation. Nuttall (J. Soc. Chem. Ind. 39, 67–73, 1920) discusses this subject very clearly. For a liquid to spread easily in a thin film on a solid the liquid must have a low surface tension, a low interfacial tension and perhaps a high surface viscosity. Solutions of alkali soaps, with their low surface tension, have high wetting powers, but a solution of saponin, with a comparatively high surface tension, has excellent wetting powers, due to its high surface viscosity. A one per cent solution of saponin wets a sheet of paraffin wax, although a five per cent solution of soap does not.

Substances that lower surface tension concentrate at surfaces or interfaces, sometimes in a film with the properties of a plastic solid as in the case of saponin. These films tend to prevent mixture and running together to form drops.

Thus saponin is a good emulsifying agent, as is an alkali soap, but for a different reason. The plastic film formed at the oil-water interface interferes with the coalescence of drops. In milk the globules of fat are surrounded by a tenacious coating of adsorbed protein.

Foaming, usually, but not always, parallels high wetting power. Saponin foams are merely plastic films resembling the "armor-plated" flotation froths.

In flotation of ores we depend upon the fact that a little added oil wets the small particles of the valuable metallic sulfide better than does water, while the reverse is true for the particles of "gangue" or waste rock. Thus, when finely ground ore is beaten with water carrying a very little of some special oil, the films of oil in the froth wet and float the copper sulfide (or other valuable sulfide). The froth is stabilized and stiffened by presence of this plastic film of sulfide particles. Removal of the froth gives a concentrate far richer than the original ore. Of course the gangue, being preferentially wet by water, sinks to the bottom of the tank. Quartz particles may be wetted even more readily by water if a little acid or base be added. This may be due to adsorption of hydrogen ion or of hydroxyl ion. Since sixty million tons of low grade ores are "floated" annually, it is evident that the topic of "preferential wetting" is worthy of study. Now it is proposed that fine particles of coal be separated from ash, or rock waste, by the use of a solution wetting the two materials in different degree.

Emulsions are dispersions of one liquid in another and are simply made by suitable mechanical agitation of the two liquids. However, the tendency of the two liquids to form two drops or layers, thus presenting the minimum of surface, is so great that to prevent coalescence of minute drops a third substance called an "emulsifying agent" must be present. As a rule the emulsifying agent is colloidally dispersed in one of the liquids; for example, an alkali soap in water. Such alkali soaps aid emulsification by lowering the surface tension of the water as well as by forming concentration films around the oil globules. Saponin, on the other hand, is a good emulsifying agent, in spite of the comparatively high surface tension of its aqueous solutions, because it concentrates at the oil-water interface to form a plastic film.

With alkaline earth soaps the oil is not dispersed in drops in water (the usual type of emulsions), but water is dispersed in drops throughout the oil (the unusual type, a water-in-oil emulsion). This is because alkaline earth soaps are more soluble in oil than in water. A rule applicable here is that if the emulsifying agent is more readily peptized by liquid A than by liquid B it will be B that is dispersed in drops. This is even true in the case of insoluble fine powders, which are more readily wet by A than by B.

Industry needs emulsions and makes them, but industry is also concerned with breaking certain annoying emulsions. To attack such a problem one must first learn what the emulsifying agent is. It may be a soap, a glue, a gum, a fine-grained sludge or a sulfonated oil. In any event it must be removed or converted into some other substance. Addition of acid to a

(*Continued on page 140*)

FIRE PREVENTION AND PROTECTION

By PERCY BUGBEE, '20
Executive Assistant, National Fire Protection Association

Fire prevention as a field for scientific study is of comparatively modern origin. Like most economic wastes, destruction and loss by fire has long been regarded as a necessary evil. Expensive and elaborate means have been developed to save life and property after fire has started, but only recently has the possibility of preventing fire before it starts been seriously considered.

It is the purpose of this article to explain briefly why fire prevention is of enormous economic importance, to tell what is now being done to combat fire waste, and to suggest a method of survey to gauge the adequacy of fire protection in any industrial plant.

Statistics on the extent of the yearly fire loss in the United States and Canada have been compiled by the *New York Journal of Commerce* for the past forty-four years. They show a steady increase of from seventy-eight million dollars in 1879 to four hundred and eleven million dollars in 1922.

More accurate statistics have been compiled by the actuarial bureau of the National Board of Fire Underwriters during the past six years and their estimate for the year 1922 is close to five hundred million dollars.

These figures represent actual property destruction by fire. They do not include the enormous indirect expense of fire such as the upkeep of fire departments, the overhead of insurance companies, and the disruption of business. This indirect loss is probably close to a billion dollars or twice the actual property loss by fire.

While no accurate statistics on loss of life are available, the usually accepted estimate is that fifteen thousand persons are burned to death yearly and seventeen thousand persons are injured because of fire. Waste of life is an economic waste that cannot be compensated by dollars.

In connection with this tremendous yearly waste of lives and property it is worthy of note that with the exception of Canada our per capita fire loss greatly exceeds that of any foreign country. This is an interesting commentary on the psychology of the American people. It indicates our careless and irresponsible habits which are perhaps the outcome of our enormous wealth. What other nation could stand with equanimity a waste of half a billion dollars yearly?

Economic justification for this waste is usually argued along one of the following two lines:

1. That fire comes in the "Act of God" class: *i.e.*, that it is not subject to human control, but is a misfortune which must be endured.

2. That the insurance companies pay for fire losses, so that there is no actual economic loss when a fire occurs.

It is not very difficult to prove that both of these propositions are absolutely absurd.

Statistics show that over eighty per cent of fires are preventable. In other words, most of the fires are caused by preventable conditions, acts of human indifference, or carelessness. There is no lack of information as to the protection of property against fire, but unfortunately there is a lack of general application of this information.

Insurance companies are necessary and valuable institutions, but they do not re-create burned property, nor do they operate mints to coin the wealth which is burned up. They simply collect from the many to pay the losses of the few. Every commodity costs a little more because of the insurance premium that the manufacturer, the middleman and the retailer have had to pay. If the fire waste is cut down, insurance costs less and the cost of living is reduced.

The science of fire prevention and fire protection had its origin about seventy-five years ago in some of the mills of New England. Through the efforts of the mill owners the automatic sprinkler was developed and other means of protecting property against fire by means of improved construction and fire fighting facilities were instituted. The mills interested in improved fire protection formed mutual insurance companies and these companies in turn attracted engineers who gave their full time and training to the development of fire protection. Other insurance companies, seeing the success of this work also engaged trained men to look after the protection of their interests and gradually through these insurance engineers and other engineers who were coming in contact with fire hazards in various industries, the science of Fire Protection Engineering was developed.

Most of this work has been sponsored by the National Fire Protection Association, which was organized twenty-eight years ago "To promote the science and improve the methods of fire protection and prevention; to obtain and circulate information on these subjects and to secure the coöperation of its members in establishing proper safeguards against loss of life and property by fire." The membership of this organization includes insurance engineers and inspectors, consulting engineers, architects, builders, fire chiefs, and anyone interested

(Continued on page 142)

International Newsreel

BALTIMORE GRAIN ELEVATOR FIRE
July 2, 1922. Loss of $1,000,000

MONTHLY NEWS

Mine Temperatures. Investigations conducted by Daniel Harrington, supervising mining engineer of the Department of the Interior, Bureau of Mines, in metal mines at Butte, Montana, indicate that surface air temperatures have an important bearing on underground air temperatures in shallow mines, or close to a downcast shaft or an intake air course in deep mines above the 2,000-foot level, particularly in those mines depending on natural ventilation. In deep mines, especially in those having mechanical ventilation, day to day or hour to hour variations in surface temperatures have very little influence on underground air temperatures below the 2,000-foot level except in summer, when outside temperatures are greatly in excess of 65° F. Even in deep mines, however, a seasonal variation below the 2,000-foot level occurs, average summer shaft temperatures being 5° to 10° F. higher than the average winter readings.

Rock temperatures undoubtedly affect air temperatures underground much more than do temperatures of outside air; on the other hand, air circulating underground has a well-defined effect on rock temperatures.

Holding Work by Vacuum. Aluminum, brass, and other non-ferrous metal parts of small or frail construction are often machined under severe handicaps because of the difficulty of holding them. With thin aluminum castings the use of clamps may result in distorting them to such an extent that they will not pass inspection, while with small brass pieces, production rates may be low because the lack of adequate holding means makes it impossible to load the machine with more than a few parts at a time. When small parts are made of iron or steel, they can be conveniently held on a magnetic chuck for quantity production. To provide for holding large quantities of small pieces made of either ferrous or non-ferrous metals, and non-metallic work, such as rubber, fabric, wood, or glass, there has been developed a line of chucks that utilize vacuum for holding work.

In each of these vacuum chucks there is a chamber which is made air-tight when the work is placed over it, either by the work covering the entire surface or by other means. A vacuum is then created by pumping all of the air from the chamber, and as this is done, the work gradually becomes secured to the chuck by atmospheric pressure. One square inch of surface is capable of holding against gravity fourteen and seven-tenths pounds or of resisting a horizontal force of four hundred and seventy pounds when a full vacuum has been obtained.

This method of holding by vacuum has been applied to drill presses, grinding machines, shapers and lathes used in the quantity production of small articles. An interesting application in lathe work is the vacuum check or arbor for holding the two halves of an automobile connecting-rod bearing while machining the outside surfaces. With the possibility of many other applications, this unique method of holding should find widespread use in industry.— *Machinery.*

Carbon Monoxide in Tobacco Smoke. The much mooted question as to whether the carbon monoxide present in tobacco smoke constitutes a hazard to the smoker in confined indoor spaces seems to have been settled as a result of tests just completed at the experiment station of the Bureau of Mines at Pittsburgh. These tests demonstrated that the danger is negligible.

The tests, which were performed in the course of general studies of the Bureau of Mines relative to gas hazards in mines, were made on three men confined in a closed chamber whose capacity was one thousand cubic feet. The three subjects puffed merrily for the space of an hour and a half at cigarettes of every variety, Turkish, Egyptian, the old Virginia brand, and the type wherein the smoker "rolls his own." Following this, the smokers drew energetically at an infinite variety of cigars — cheroots, Pittsburgh stogies, black Manilas and Havanas of choice degree. Finally they puffed frantically at pipes, at pipes of clay and cob, at pipes of meerschaum and briar. At the conclusion of the performance the air of the closed chamber had become so smoky that it was impossible to see across the room. The atmosphere was so irritating to the eyes that it was necessary to wear goggles.

Samples of the atmosphere and blood samples of the smokers were then taken for analysis. It was found that in no instance did the carbon monoxide content of air exceed one one hundredth of one per cent. The maximum blood saturation was five per cent. Some of the subjects supposedly inhaled their smoke, but the tests indicated that such inhalation, though it may have extended to the bronchial tubes, did not penetrate throughout the lungs. The tests indicate that carbon monoxide hazard from smoking indoors is negligible in itself, although the Bureau of Mines investigators consider that it may add to the smoker's hazard should he be caught by carbon monoxide from sources such as occur in the mining industry.

Concrete Railway Ties. The Northwestern Railway of India has made exhaustive tests of a new type of concrete railway tie patented by a Delhi Consulting Engineer. Experiments have been made on fifty miles of main line track near Delhi and the results have been so satisfactory that a further seventy miles of track will be similarly equipped as soon as the necessary ties are manufactured, says a report to the Department of Commerce from Vice Consul Robert F. Kelley at Calcutta. The tie consists of two concrete blocks joined together by a tie bar, the rails being fastened by means of a screw or dog spike driven into wood plugs, specially treated and compressed, set in the bed of the concrete block. The other Indian railways are interested in concrete ties. The East Indian Railway has been using a large number of Greene-Moore patent reinforced concrete ties for seven years and has now nearly completed a factory for manufacturing five hundred thousand railway ties per annum. The Greene-Moore tie is the invention of the Deputy Chief Engineer of the East Indian Railway and is similar in construction to the type in use on the Northwestern Railway.

Making Colored Glass Caps for Telephone Signal Lamps. Those of us who have seen a telephone switchboard in action, with its thousands of tiny lights flashing, have given scarcely a thought to the effort put into such a tiny detail as the caps whose color or markings tell the meaning of the lighted lamp behind it. Before the war the glass used in them came from overseas. Now, as has so often happened, we are making them better here.

Glass — one of the real "old timers" among manufactured products — is made by melting up a mixture of sand, soda ash and many other things. When the mixture is ready, the workman dips a rod into the glowing sticky mass and gathers a ball of it on an iron rod. By skillful rolling on an iron slab and reheating in a furnace, he brings it to the right consistency. Then his helper jams against the mass a hot iron disc and slowly backs away. The glass strings out like taffy into a rod about thirty feet long, which is laid down on an asbestos carpet to cool. Then it is cut up into rods of convenient length.

Lamp caps are made in a punch press, just like collar buttons. The operator first heats an inch or so of the end of a glass rod and feeds it into the press, which stamps out the softened glass. By the time that three or four caps are pressed, the rod has grown cool, so another hot rod is substituted, and the first one is heated again. When the rod is too short to hold, the stub is tacked to the end of a new rod, just as you stick the stub of a candle to a fresh one. The completed caps are mounted in a brass punching which eventually finds its way into a telephone switchboard somewhere.

In the old taffy-pulling days it was easy to make almost any color desired and the pullers were sure that red taffy would still be red taffy when it was finished. This is where the glass maker's wizardry is fascinating as it is baffling. The ordinary bystander cannot guess from the ingredients what color is going to be produced and in what mysterious manner. Coloring glass has nothing in common with coloring candy or painting a house.

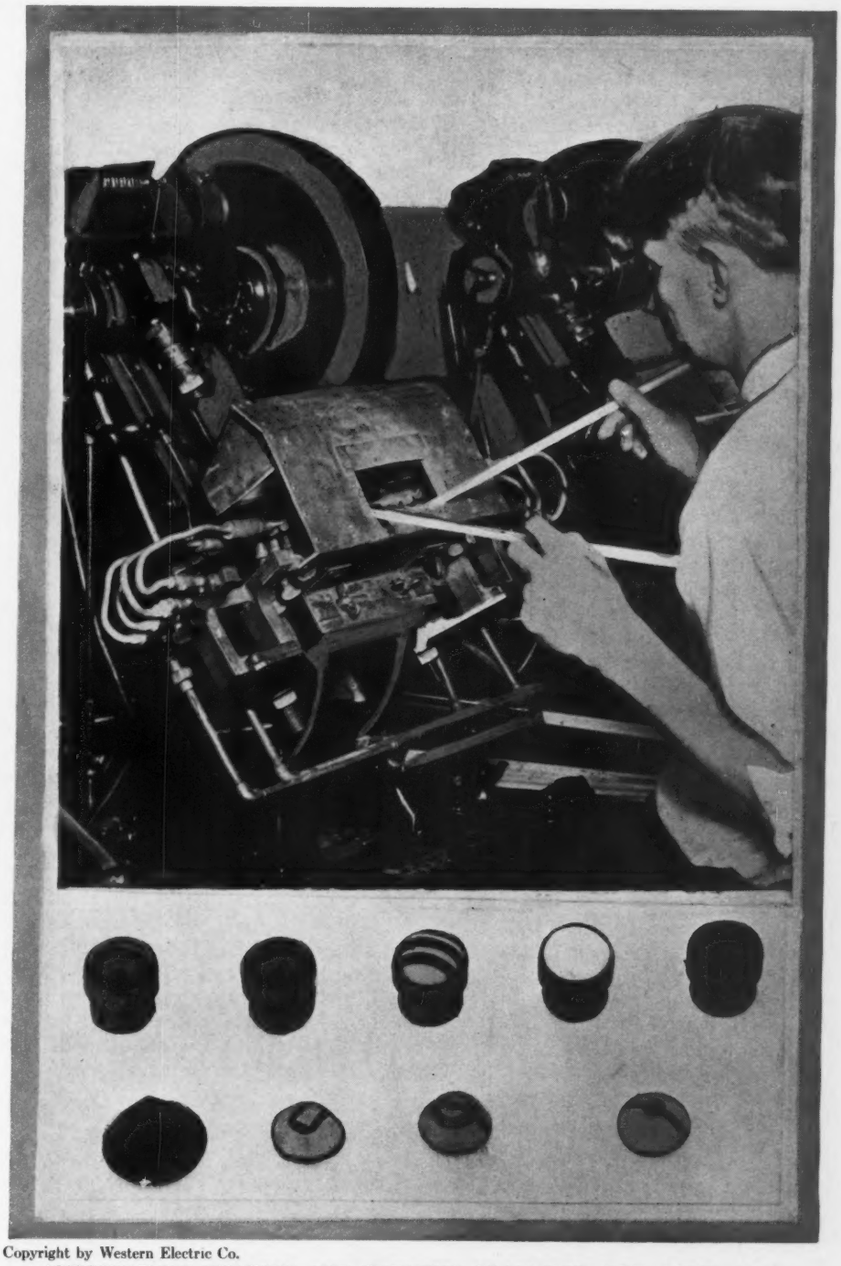
Red glass is made by dissolving a minute quantity of gold in the "melt"; green glass contains copper oxide and sodium dichromate; and opalescent glass contains cryolite and bone ash.

Next time you "flash" your telephone operator by working the hook-switch, give a thought to the Chicago "taffy-puller" who did his part toward your telephone service.

— *Western Electric News Service.*

BOOK REVIEW

Electricity and Its Application to Automotive Vehicles. By Paul McDowell Stone. D. Van Nostrand Company, New York. 834 pages plus xvi and index. 395 Illustrations 6 x 9 inches. 1923. Price $4.00.



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ALTERNATELY HEATING AND PRESSING GLASS ROD INTO LAMP CAPS OF THE KIND SHOWN BELOW

We cannot imagine an automobile without its more or less complicated system of electrical starting and lighting fixtures. The days of the hand crank and the gas lights have gone forever and in their place has come electricity. The knowledge of the mechanical principles entering into the construction and operation of a motor car is no longer sufficient for the student, mechanic, or owner. To know a car thoroughly is to become familiar with the electrical end as well as with the mechanical end.

This book by Paul McDowell Stone presents the subjects in a way that can well be understood by a person not having the advantages of a technical education. Through years of experience in teaching the subject at Michigan State Automobile School the author has learned the requirements of the student and repairman.

EDITORIALS

TO THE FRESHMEN

Whenever a young man starts out on a new venture, his older friends and relatives always feel called upon to offer a little helpful advice. Perhaps it is with this spirit that the present editorial is written. It is not, however, without a sympathetic understanding and a warm feeling of welcome. We want the Freshmen to feel that THE TECH ENGINEERING NEWS aims to serve them to the fullest extent possible.

It is remarkable how many young men come to the Institute with a very hazy idea of "what it's all about." Undoubtedly, this is due to the fact that only a few of them have ever done much thinking on the subject. It is not, as it should be, a life problem calling for any new point of view on their part. They accept it as the necessary thing to do in order to make a success in business or engineering without truly knowing whether they want business or engineering success. Little more can be expected from them, coming, as most of them do, from an environment which makes business success seem the only true one.

To the few whose environment has been different but who are still swayed by established custom, let them be absolutely sure that they know what Technology is and that they really desire to come. A great many of the failures at the Institute are due to this very fact of not realizing what an essentially technical training is and what it leads to. They come, carefree and half-blinded by established custom, only to revolt against the whole order of things. How much better it is to know and be sure first, then act.

To those who, either by the overwhelming force of environment or through actual, careful thinking on their part, are convinced that Technology is the place for them, let those realize the possibilities of a broad education at the Institute. Let them see the necessity for it — the bearing it has on success in their chosen field. Let them realize, above all, that their main purpose should be to obtain education, not a mass of specialized information.

It is not our purpose to set forth here the educational and broadening possibilities of the Institute. These will become apparent to any Freshman who is on the lookout for them. In fact, many of them will be thrust upon him to make the most of. Perhaps the best advice as to what he should watch for is given in the words of Thomas Huxley on education:

"That man, I think has had a liberal education, who has been so trained in youth that his body is the ready servant of his will and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by vigorous will, the servant of a tender conscience; who has learned to love beauty. whether of nature or of art, to hate all vileness, and to respect others as himself.

"Such an one and no other, I conceive, has had a liberal education; for he is, as completely as a man can be, in harmony with nature. He will make the best of her, and she of him. They will get on together rarely; she as his ever beneficent mother; he as her mouthpiece, her conscious self, her minister and interpreter."

FIRE PREVENTION AND YOU

The week of October 7 has been set apart as National Fire Prevention Week. It is deserving of more than passing notice. The knowledge of the average college man regarding fire prevention and losses is negligible, and since, some day, he will be the owner of buildings and property it is of the utmost importance that he take interest now in the methods of fire prevention to guard against future losses.

It is not our purpose here to acquaint every one with facts and figures, but to correctly appreciate the great importance of this question it is well to keep one or two facts in mind. The construction in the year 1920 amounted to $1,580,000,000 but the loss by fire was $580,000,000 or over one-third of the total value of construction!

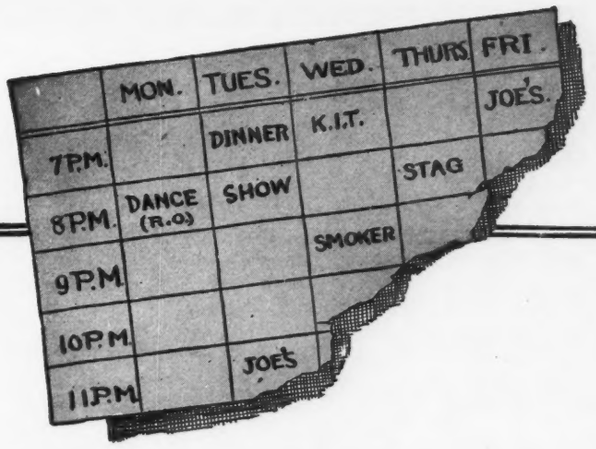
This is not only a monetary loss but it strikes deeply — it goes back to our national resources. An appalling proportion of our resources goes into smoke and ash heaps. All of this is depriving future generations of the inheritances which should be theirs.

In Germany, France, Switzerland and Italy, the loss by fire averages only thirty-five cents per capita. In the United States it averages five dollars and twenty-four cents per capita — fifteen times as much. It is here clearly demonstrated that fire loss can be lowered. The present generation should carry out measures to accomplish this end.

Every one is familiar with the expensive system of fire protection; the fire departments, Underwriters Laboratories, inspection service, and the like. But prevent fire and the protection is unnecessary. Huge sums are spent upon beautiful structures — architectural triumphs — with lavish decorations and adornments, but huge sums are paid also to insure the owners of these edifices from loss by fire. Yet insurance does not immunize the buildings themselves.

However, not alone from the mercenary standpoint should these things be viewed, but also from quite another angle, the viewpoint of humanity. Thousands of lives are lost by fire each year, the value of which cannot be estimated in dollars and cents.

It behooves us all on these accounts to observe and learn from this week all that it offers. From the humanitarian viewpoint alone the end is more than justified by the saving in human life, but to the other classes it has also a distinct appeal. No one cherishes property and pecuniary loss and the lavish wastefulness with which our forests and other natural resources are being exploited brings us face to face with the question of safeguarding the rights of our posterity.



Does your P. M. schedule read like this?

If your burning ambition is to excel as an all-around society man, you couldn't have planned your evenings better. Such persistence will win out over the indolence of the rank and file, for as the poet says,

"The heights by great men reached and kept
Were not attained by sudden flight,
But they while their companions slept
Were toiling upward in the night."

But if you intend to make your mark in engineering or business, don't expect that supremacy on the waxed floor will help when you start hunting a job.

Not that you need swing to the other extreme as a "grind" or a hermit. Let's concede it is all right to minor in sociabilities—but certainly it is only common sense to major in the math and sciences and English that will mean bread and butter to you later on.

Remember this—the harder you work right now in getting a grip on fundamentals, the easier things will come to you when you must solve still bigger problems. And if you take it easy now—well, look out for the law of compensation.

It's up to you. While you've got the chance, seize it, dig in, plug hard. It will pay—in cold cash.

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Western Electric Company

**Two years ago this advertisement appeared in the Western Electric college paper series. It received so much friendly comment from your faculty and alumni, including some graduates who have since entered our business, that we now reprint it —as a suggestion in this busy month of schedules.*

COLLOIDAL CHEMISTRY

(*Continued from page 134*)

soap is effective because this liberates the fatty acid, a poor emulsifying agent. A dehydrating agent may ruin the effectiveness of a highly hydrated emulsifying agent. Since oil particles carry a negative charge of electricity, they may coalesce if this charge is neutralized by ions of high positive charge such as Al +++ or Fe +++. Also, if the droplet charge is almost neutralized by addition of a suitable salt the emulsion may become so unstable that filtration through proper material will completely separate oil from water.

Lubricating greases are emulsions of three to five per cent water in a soap oil system. The soap, usually a calcium soap, although aluminum soaps are also in use, is dissolved in the hot oil, a heavy petroleum fraction. The mixture is stirred while cooling and the water added below one hundred degrees. Separation of oil from soap on long standing is checked by the presence of water droplets. It is probable that some alkali soap is added to increase the viscosity of the water droplets. Cheaper greases are made by the use of soaps of the rosin acids.

Nuttal, in his fine paper already referred to, points out that a disinfectant must wet the surfaces it is intended to disinfect. Chick and Martin (J. Hygiene, 8, 698–703) believe that with coal tar disinfectants the bacteria are adsorbed on the emulsified particles of the tar acid, thus being brought into contact with disinfectant in a most concentrated form. Sprays must wet green leaves. "By incorporating an oil emulsion with the dip, and thus ensuring high wetting power, Cooper showed that it was possible materially to reduce the sodium arsenite content of the dip and yet ensure destruction to the tick without injury to the cattle. This application alone of wetting power has been instrumental in clearing large tracts of tick-infested country in various parts of the world."

Wetting power has been discussed here in some detail as an illustration of what any chapter in colloid chemistry may lead to if applied as carefully. Space lacks for an adequate discussion of the enormously important topic of adsorption.

Adsorption of toxic gases by cocoanut charcoal is familiar to all after the experiences of the Great War. Yet the application of the principles of gas adsorption by activated carbon, silica gel, etc., is now a peace time matter of great commercial importance. Silicic acid, formed as a gel, washed and dried to a content of eighteen per cent or less, is a glassy material shot through with innumerable capillary pores of diameter not much greater than that of molecules. In these capillary pores gases are brought well within the range of molecular attractive forces and so are held or "adsorbed." This adsorption is preferential for various gases but it may be mentioned that such a "gel" is a powerful dryer, that it removes gasoline from casing-head gas and that it removes obnoxious sulfur compounds from crude petroleum thus suggesting the possibility of dispensing with the costly sulfuric acid treatment in refining petroleum.

The power of silica gel to adsorb sulfur dioxide and the oxides of nitrogen suggests its use in connection with the Gay-Lussac tower of a sulfuric acid plant.

The use of fuller's earth in oil refining is an application of adsorption as is the use of bone char in decolorizing the syrups in sugar refining.

The physical condition of the soil, its colloid content, have everything to do with its power to retain water, to hold and adsorb the fertilizing salts so vital to plant growth.

According to W. B. Hardy, a good lubricating film must be powerfully adsorbed by the bearing surfaces, otherwise the film will tear away in spots and seizure of the metal surfaces may result. It is an interesting fact that Southcombe and Wells found the addition of one per cent of the free fatty acids of rape oil, for example, to a petroleum lubricant, added as much to the effective lubrication as addition of more than ten per cent of neutral rape oil itself. This must mean a superior lowering of the interfacial tension between oil and metal. Of course a very low interfacial tension is necessary to film formation and penetration to all parts of the lubricated surfaces.

Many wheats (as California wheat, for example) yield weak gluten flours. Such gluten in the bread dough does not stretch well enough for a good loaf and admixture with a strong gluten flour is necessary. The protein of corn, rye and other grains is "weak" in the sense that it does not permit the manufacture of a satisfactory light, porous loaf. The colloid chemist who can so change the physical condition of corn or rye or oat protein that it will stretch like the best wheat gluten will add untold wealth to the world and have much to do with checking famines.

The de-inking of old newspapers is a conservation measure of first importance. S. D. Wells reports that this may now be done successfully and the pulp worked over into paper. It is easy to loosen the carbon black by dissolving the varnish with alkali, but unfortunately the paper fibers enmesh the loosened carbon. However, by adding to the wet pulp some Wyoming bentonite, a highly colloidal "transported, volcanic ash," the carbon will be adsorbed by the clay rather than by the paper This bentonite is so finely divided that a water suspension of it passes through a filter paper even though it carry the carbon with it. Over seven thousand tons of newspapers are printed daily

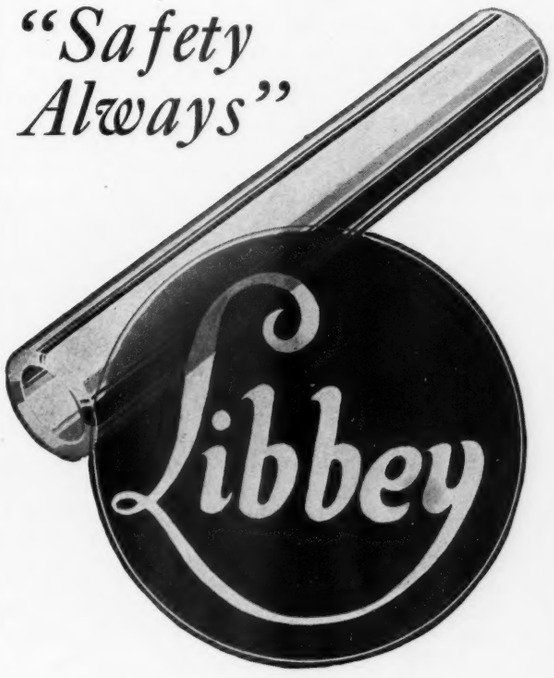
Sheppard and Bates have invented a process for peptizing (subdividing to colloidal size of particle) powdered coal in fuel oil. The coal, even the worst grades, is pulverized until ninety-five per cent will go through a one hundred mesh sieve and eighty-five per cent through a two hundred mesh sieve. Stirred with fuel oil carrying less than one per cent of the peptizing agent, a remarkably stable liquid suspension is obtained. As much as forty per cent of it may be coal and yet it is so fluid that it can be sprayed like fuel oil and burned under boilers. This "colloidal fuel" would be excellent for ships, partly because the fire hazard is less than that of oil. As the fuel is heavier than water a fire could be put out without serious trouble. The combustion of such a sprayed liquid is so good that the lowest grade coals, even lignite, can be utilized.

All glues are hydrated colloids hence when dry they tend to take up water from moist air and thus weaken. To so change these glues that they will not rehydrate after drying and yet will regain their adhesive power is a problem of vast importance. Large timbers are becoming scarcer and we are being forced to the use of timbers built up from smaller pieces. Present-day glues greatly limit the period of usefulness of glued woods. They weaken too soon.

Metals and alloys, at a certain stage of their existence are in a colloidal state and, although this stage may be brief, a portion of the metal or alloy tends to remain in the colloidal state and exert a powerful influence upon the physical properties of the final solid mass. (Alexander.)

These few applications of colloid chemistry may serve as an incentive to further reading. For such reading I urge the purchase (at a small price, fortunately) of the "First, Second, and Third Reports on Colloid Chemistry and its General and Industrial Applications."

"Safety Always"



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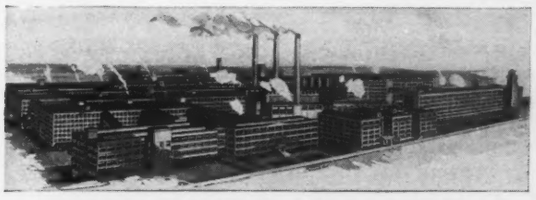

The plant of Goodyear, shown above, has 85 Haughton passenger and freight elevators. Goodyear uses 96 Haughton Elevators in all.

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FIRE PREVENTION AND PROTECTION

(*Continued from page 135*)

in fire prevention and protection. The technical work of the Association is carried on by some twenty-five committees covering such subjects as automatic sprinklers, building construction, electrical hazards, inflammable liquids, and protection against lightning. The carefully prepared standards which are issued as a result of this work are available to all engineers in all industries.

Apart from the technical development of fire prevention the movement has made slow progress, but at the present time the signs indicate a more general interest in conservation of lives and property each year. Most of our states now have a Fire Marshal or a Fire Prevention Department which is doing valuable educational work in fire prevention. Fire chiefs are coming to realize the value of fire prevention and are helping to educate property owners to fire hazards. Fire Prevention Week, sponsored by the National Fire Protection Association and receiving the endorsement of President Wilson and President Harding, has resulted in much valuable public education in fire prevention. Some of the schools are now instituting courses in fire prevention to impress upon children the fact that fire prevention is part of their obligation as citizens.

Armour Institute of Technology is the only institution of higher education that has a full four year course in fire protection at the present time. The demand for the graduates of this course has been very great in industry and in the insurance companies. Massachusetts Institute of Technology has a short course, optional with the students in Mechanical Engineering.

Other colleges giving courses in fire protection at present are University of California, New York University, University of South Carolina, and University of Florida.

Undoubtedly many of the present Tech undergraduates will have to face the fire prevention problem when they enter the industrial world. Fire prevention is very often sadly neglected or ignored by the management and workmen of industrial plants and it is therefore a field where prolific results can be obtained by an engineer who is cognizant of its importance. The following is a very brief outline of some of the many features which have to be taken into consideration in sizing up the fire safety of an industrial plant.

The location of the plant is of considerable importance. The chance of damage due to fire in an adjoining or nearby building must be noted. The character and probable fire hazard of neighboring plants or buildings will have a bearing on the protection needed. The accessibility of the public fire department and also of an adequate water supply must be taken into consideration.

The ability of the plant structures to resist fire must be studied. This means not only the character of construction but includes a study of the extent of open area subject to fire damage, the protection of wall and window openings and of vertical shafts and stairways. A plant may be of reinforced concrete construction but if it is packed with inflammable contents it will burn just as the contents of a stove will burn. It must be provided with proper fire walls with automatic fire doors, wired glass windows in metal frames, fire shutters, etc., for if there is a weak spot in the construction the fire will find it. The plant must contain adequate exit facilities such as enclosed stairways or smoke proof towers to insure life safety.

Underwood & Underwood

NEW YORK WAREHOUSE
July 18, 1922. Loss of $1,000,000

A survey of the fire protection equipment in a plant involves a knowledge of automatic sprinkler systems, standpipe and hose systems, hand fire extinguishers, fire pumps, gravity tanks, and automatic fire alarm service. The ability of employees and watchmen to handle the apparatus in case of fire must also be investigated. It should be noted here that automatic sprinkler systems have shown a remarkable efficiency in checking and extinguishing fires. A study of the action of sprinklers in a large number of fires in various industries shows that the sprinkler system is somewhat over ninety-five per cent effective.

The layout of plant processes and buildings often has an important bearing on the possibility of serious fires. The particularly hazardous processes must be marked and their segregation from other processes considered. The possibility of rooms in which valuable stock is kept being exposed to fire or water damage should be noted. The possibility of spread of fire through a building or to adjoining buildings must be examined.

The chief sources of fire hazard encountered in any industry can be listed as follows, approximately in order of importance: smoking and the careless use of matches, electricity, heating plants, inflammable liquids, spontaneous ignition of rubbish or waste, sparks from machinery, and use of open lights. The situation with regard to each one of these should be checked up so that obviously dangerous conditions can be eliminated. It is often easy to find most flagrant disregard of ordinary precautions against any of these hazards.

In the majority of industries there can be found one or several processes peculiar to the industry which involve a fire hazard. For example, picker room fires are very prevalent in cotton mills. Dry kilns and shavings vaults are common starting places for fires in the woodworking industries. Dip tanks are danger spots in automobile factories.

It is very important that such processes receive careful attention with the view to necessary protection against fire. Special processes are usually vital to an industry and fire damage to them is a serious loss and inconvenience.

It must, of course, be realized that considerable special knowledge is necessary in making a thorough survey of plant fire protection. But, with a comparatively small amount of thought and research on the subject, any engineer should be able to make a survey of the nature described which can be of real value in promoting the safety of his plant.

Steam Turbines and Electric Generators Exported. Figures given out by the Bureau of Foreign and Domestic Commerce show that there were exported during the first six months of 1923, from the United States, 38 steam turbines, 10,619 direct-current electric generators under 500 kw. capacity, 266 direct-current electric generators of 500 kw. and over, 116 alternating-current electric generators of 200 kw. and over.— *Power.*

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CAMBRIDGE, MASS.

SCULPTURE BY PHOTOGRAPHY

(Continued from page 129)

If we can place before a camera a solid object, as for example the head of a man, and obtain as the result of purely automatic, or at any rate semi-automatic process, a faithful rendering of the form of such object carved in wood or ivory, in wax or steel, we have arrived at a satisfactory starting point which is at least an interesting topic for the consideration of the scientifically inclined.

As to the views which the artistically inclined may hold to such a proposition this is a very delicate subject, and I would prefer to say nothing which might wound the susceptibility of those who believe that the purity of the work of the artist is tainted by resource to anything mechanical. I imagine that no two artists think exactly alike on the subject as to what may or may not be "fair" aids in producing these results. The camera has been called in by the artist often, perhaps to an extent which he would prefer not to acknowledge. Leonardo da Vinci is said to have employed a wire mesh in the form of a square, like a transparent chess board, and a fixed point of observation, using thereby the same means which are commonly employed by the copiers of pictures. It is also recorded that in making his preliminary studies for sculpture he posed his models in a bath of known dimensions, and by filling to various heights he was able, by measurement, to draw a series of accurate parallel sections of the form. These, or any other mechanical devices which the artist may employ, have for their object to assist him in the accuracy of his results as a copy of nature and his artistic talent or genius will be called into play to produce a work of art by the exercise of composition, selection, craftsmanship and the other qualities by which the lifeless material is made into a thing of beauty.

To advocate a process by which these qualities of the artist are pushed more or less into the background would seem to be a hopeless task. It is, however, true that the "quality" which the results of Photo-Sculpture exhibit, possess something which compels the admiration of the artist who sees in them a handling of planes and delineation of form, which would, if produced in the ordinary way, represent a very high degree of talent. This is really putting the case very mildly for Photo-Sculpture. As we know, the accuracy of the modern photographic lens is very great, and for example, no human being exercising the greatest care could copy a map or picture or engraving with anything like the accuracy with which the photographic camera can accomplish this feat in the fraction of a second of the time. So in Photo-Sculpture an exposure of five seconds is enough to obtain photographic records from which a carving representing a very faithful reproduction of form can be made.

FULL FACE PORTRAIT

In conclusion I would express the hope that this new application of science to art should be treated with the tolerance which should always be accorded to efforts in a new direction.

Painting of Oil Tanks. A large scale test of the value of different colored paints for the reduction of evaporation losses from oil tanks will be made by the Department of the Interior through the petroleum experiment station of the Bureau of Mines, Bartlesville, Oklahoma. Oil refineries have been greatly interested in this problem.

In the past, many oil operators, especially throughout the eastern and the middle western fields, have adopted white or light-colored paints for storage tanks. Tests previously made indicated that evaporation from tanks painted white averages about one to one and one-half per cent less than from tanks painted red, and about two and one-half per cent less than from tanks painted black.

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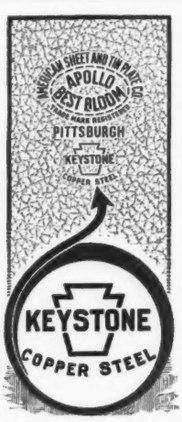

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Neither have the builders of such systems been concerned only in the actual hauling of people and materials. A study of the methods of handling passengers and freight at the large terminals has developed the Terminal Engineer, who has greatly improved existing methods, and has developed entirely new ones, as well.

Engineering, as it is applied to transportation, has had to concern itself with many kinds of materials and many ways of handling them under all manner of circumstances. For instance the problems surrounding the handling of iron ore, in bulk, are vastly different from those encountered in moving any one of the finished products manufactured from iron ore, that must also be transported in large quantities. But Engineering constantly meets each situation with improved transportation facilities.

Industry, as a whole, and the nations and the people of the world owe much to the engineers, associated with such large manufacturing industries as Westinghouse. They have not only brought about vast improvements, but they have done so at a constantly decreasing cost to those who derive the greatest benefit from them.

Westinghouse

ACHIEVEMENT & OPPORTUNITY

W

WESTINGHOUSE ELECTRIC

GEORGE K. BURGESS

(Continued from page 131)

Doctor Burgess has always recognized the important primary function of the metallurgical division as a clearing house for the latest technical data regarding metals and metallurgy. The large volume of correspondence calling for such information shows that this service was appreciated and is an index to its value. In this connection Doctor Burgess planned a series of information circulars which were prepared by the metallurgical staff. Notable examples are the exhaustive compilations of technical facts concerning special groups of metals as given in the circulars of the Bureau of Standards on "Copper, Nickel, Aluminum and Its Light Alloys." The latter accelerated the post war extension of the use of light alloys.

The work of Doctor Burgess in connection with the standards of quality for metals, commonly called specifications, has been of great importance. He served as expert on the International Aircraft Standards Board, organized in 1917 by the technical representatives of Canada, France, Great Britain, Italy and the United States. He was chairman during 1922 and 1923 of the Metals Committee of the Federal Specifications Board, of which board he is now chairman.

In the spring and summer of 1917 Doctor Burgess went to Europe as a member of the First Scientific War Mission to Europe for the purpose of gathering data on the applications of science to warfare. On this mission he visited laboratories, manufacturing plants and technical services at the battle front and rear of both the French and English armies. From this visit Doctor Burgess brought back technical military information of the utmost importance. On his return to Washington he was probably the best informed expert in Washington on the newer applications of science to warfare.

In addition to his administrative work Doctor Burgess has personally conducted laboratory research problems affecting metals, and in all cases he has shown the great value of scientific research applied to industry. His work on railway materials offers a good example. Doctor Burgess personally demonstrated in the steel mills that it was practicable to measure the temperature of steel rails as they passed through the rolls. Since the practical men in the mills were at first incredulous he personally visited rail mills and with the help of one assistant measured the temperatures on the regular output of rails under actual working conditions. Dr. Burgess also successfully demonstrated methods of producing sound ingots. Prior to that time fatal railroad accidents were often caused by occasional insufficient discard of the ingot with consequent unsoundness in the rails. With the coöperation of the head of the British Iron and Steel Institute, Doctor Burgess demonstrated in the presence of railroad engineers, practical metallurgists at the steel mills and technical experts in metals that it was feasible by newly developed methods to produce sound ingots from which sound rails could invariably be rolled. Doctor Burgess also collated and published the standard specifications for railway materials of foreign countries and this publication did much to influence American practice. The studies of Doctor Burgess of failures in railway carwheels, in which it was demonstrated failure was caused by the thermal stresses set up in the plate of the wheel by heating of the tread from the application of the brake-shoes, is another striking example of his success in applying scientific laboratory methods to the solution of important industrial problems.

On April 21, 1923 on recommendation of the Secretary of Commerce, the President of the United States appointed Doctor Burgess Director of the Bureau of Standards of the Department of Commerce, subject to the approval of the United States Senate. At the time of his appointment to the directorship of the Bureau, Doctor Burgess had placed the Division of Metallurgy on a smoothly working basis. His close contact with the industries and with other branches of the Government concerned with metallurgical problems, his scientific training and experience, his active membership in many scientific and technical societies on whose committees he served with distinction, and finally his election as president of the American Society for Testing Materials, and nomination for the presidency of the American Society for Steel Treating, all add unique qualifications for the important post to which he was appointed by the President.

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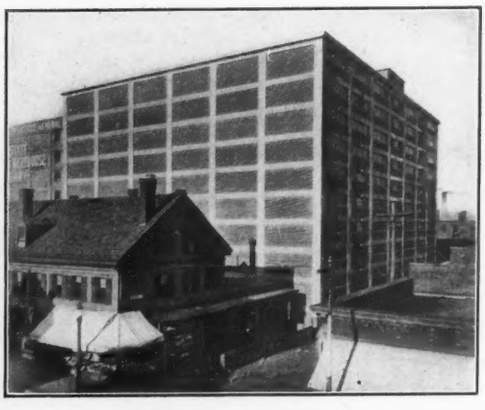

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But the handling of such a vast weight in this manner brings into action that destructive force — slow friction. Slow friction under great pressure would crumble a mountain of adamant, would pulverize the pyramids; and reduce a blacksmith's anvil to a handful of dust. And so between the great shaft and the vast bulk of its steel housing is placed a Bunting phosphor bronze bushing bearing to protect the shaft and housing from destruction by the terrific stresses which they bear.

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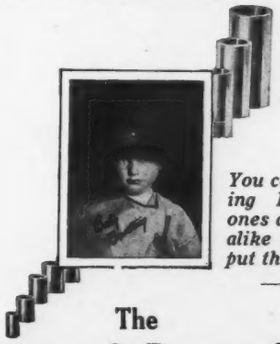

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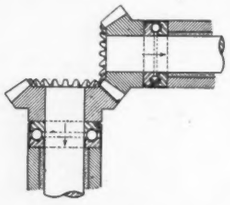

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HIS MAJESTY, THE ENGINEER

(Continued from page 125)

of the individual who originates an idea and invariably, if granted, are assigned to the company. Unlimited opportunity is afforded the man who shows resourcefulness and he is advanced as rapidly as possible to a position of greater responsibility and authority where his talents will have greater advantage.

The United States Government to date has granted over one and one half million patents, and it is a safe hazard that at the present time the average number of patents granted this company is well over four hundred annually.

How much has been loaned to the progress of civilization by the engineer would be difficult to conceive, yet rarely, if ever, do we pause in our acceptance and utilization of modern improvements to consider how the fact of the earth's comforts and our daily lives have been changed by him.

He conceives his work as building for nations — not for parishes. He spans chasms, joins oceans, tops and tunnels mountains — makes possible the throwing of the human voice over thousands of miles of land or ocean without the aid of wires. He uses heat to make it cool and uses cold to make heat. He forces nature to yield her secrets, one by one. He is essentially a builder and rarely tears down except for the purpose of building anew and better.

The field covered by science and engineering is so vast that it is difficult for an individual to realize more than a fraction of what is being done, whether it be in regard to the study of materials and their behavior under the more exacting conditions or in regard to such matter as accuracy of measurement. The further we consider the matter, the more fully we must realize that science and engineering are most intimately interwoven.

It was the accepted theory for generations that civilization followed the flag. The twentieth century conclusion is that civilization follows transportation and communication, and always in the van marches the trained engineer!

Manufacture of School Slates. Several million school slates are manufactured in the United States every year and about ninety per cent of them are exported, according to the Department of the Interior.

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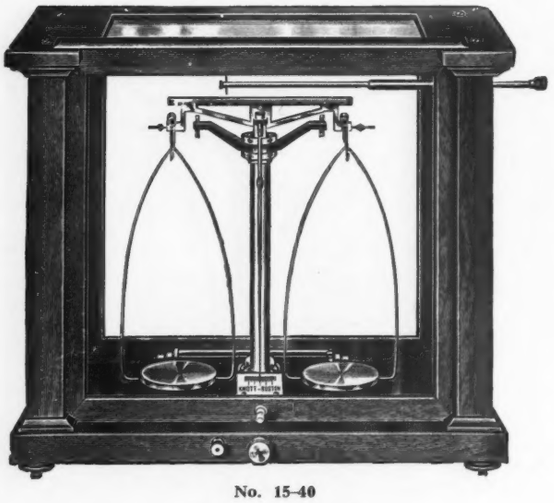

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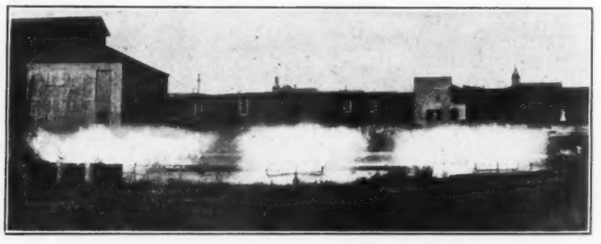

In connection with the Municipal Power Plant of the City of Dothan, Alabama, capacity 3,000 gallons per minute.

Note the uniform spray, even distribution and clear air passages. The Superintendent reports that when carrying full load in the hottest days of summer they never obtain less than 27 inches vacuum. In November last they were running with 29.6 inches vacuum. They changed from the old spray system to the new "SPRACO" inside of forty-eight hours.

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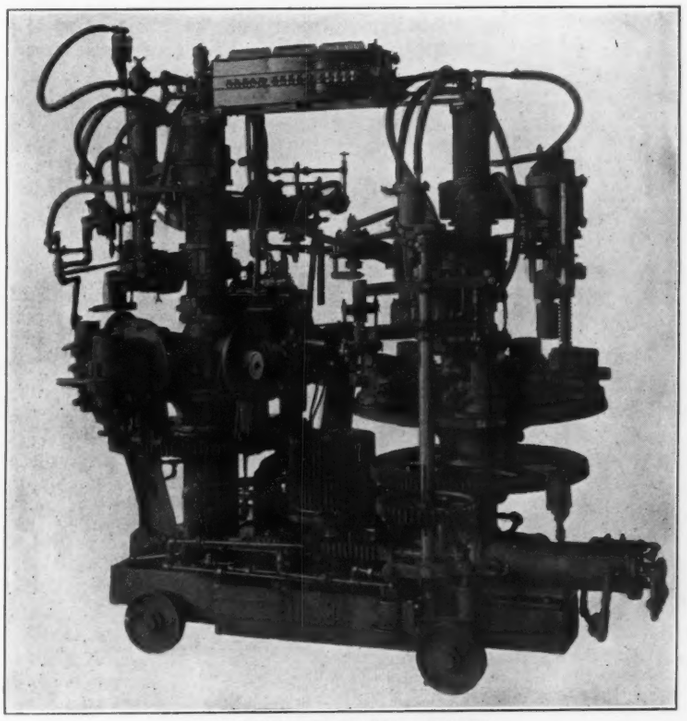

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TO most people it means the world's most sanitary container, urgently desired when its use is necessary. Little thought, however, of other than a utilitarian nature is given to the bottle itself and few consider its manufacture. Yet to a select number, it is the practical fulfillment of many years of careful and exhaustive study and experimentation.

For behind the glass bottle is the automatic molding machine, with which skilled workmen rapidly produce this necessity. The device is the nucleus of the bottle industry and upon it has been lavished infinite experience and research in order to perfect its product.

The SALEM GLASS WORKS, pioneer bottle manufacturers, have not only contributed much towards supplying the ever increasing demand for better bottles, but they have, as well, made numerous improvements on the bottle molding machine. Their staff of engineers and experts is ready at all times to give their prompt attention to your container problems and requirements.

SALEM GLASS WORKS

SALEM, NEW JERSEY

PRODUCERS OF BETTER BOTTLES

THE FOUNDERS OF THE INSTITUTE

(*Continued from page 127*)

excavations, should be prepared to judge of the value of the rocky materials he encounters in building an embankment, and should be qualified to form an estimate of the relative advantages of different districts as influenced by the extent of the mineral products.

"Instruction in all these and other kindred particulars, essential as it is to the fullest success in the several pursuits referred to, involves, it will be seen, no insignificant acquaintance with some of the leading branches of mechanical and even geological and chemical science.

"If we turn now to the manufacturing arts, we shall find an equal, and in many cases even a more urgent demand for scientific guidance. . . ."

His resignation of his professorship and removal to Boston followed in 1853. He had no academic post but was abundantly occupied with diverse scientific and civic pursuits, including remarkable expository lectures on scientific subjects before the Lowell Institute and other audiences. With continually extending acquaintance among the best of New England society he laid, with Mrs. Rogers, secure foundations for the future school. The nearby Lawrence Scientific School which might conceivably have made the new undertaking superfluous, as it inevitably made it difficult, was then and for decades after, too restricted in its aims, too much hampered by control of a conservative university, considerable as the incidental advantages of that connection naturally were, to meet the needs of a great industrial community.

Not long after his removal from Virginia to Boston, Rogers became associated with a group of public-spirited citizens who were seeking to secure the allotment of a tract in the newly reclaimed Back Bay for a variety of public purposes — some of them more or less visionary in character. January, 1860, he writes: "We ask for from eight to ten acres of the Back Bay land for buildings to accommodate the Natural History, Horticultural, Agricultural, Technological, etc. societies. The plan is magnificent." In November of the same year he prepared a notable and comprehensive report on the Objects and Plan of an Institute of Technology, including a Society of Arts, a Museum of Arts, and a School of Industrial Science. This was widely circulated as a basis for participation of persons interested and a preliminary organization of the new Institute was effected in January, 1861. The application for a grant of Back Bay land rejected in 1859 and 1860 was at last in a limited sense successful, the grant being restricted, however, to the perpetual use of two-thirds of one block, with the ungenerous condition that the value of surrounding land should thereby be enhanced by an amount sufficient to cover the value of the square granted. In June, 1861, Rogers was appointed to a new office, as Inspector of Gas Meters and Illuminating Gas for the State at a salary of three thousand dollars.

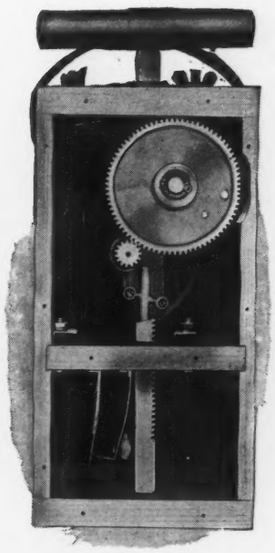
The Civil War naturally paralyzed the development of the Institute, and it proved impossible to secure the one hundred thousand dollar guarantee fund during the year allowed by the Act of Incorporation. Near the close of the period a letter from Mr. Ralph Huntington — whose name Huntington Hall commemorates — announced a future bequest of fifty thousand dollars, and an extension of time was granted. April 8, 1862, Rogers was formally elected President of the Institute, which held its first annual meeting May 6. The first public meeting of the Society of Arts followed in December of the same year. In the summer of 1863 Rogers writes his brother Henry — now professor in Glasgow — for information in regard to European technical schools. In May, 1864 his "plan for the various branches of teaching, etc." was adopted by the Government and published in the "Scope and Plan of the School of Industrial Science of the Massachusetts Institute of Technology, our true educational program and charter." Starting for Europe the previous April he writes to his brother Henry: "The two matters which I shall especially desire to look into when abroad are (1) the best means of collecting a large suite of models of elements of machinery, of bridges, roofs, arches and other works of civil construction and architecture, to be used as aids in our School of Practical Science, and (2) to examine the recent and best arrangements for working laboratories and lecture rooms. Our building will probably be roofed in by next winter, but the arrangement and fitting up of the interior I shall keep until a later time, when it may be done with a full knowledge of all that it is needful to provide for our objects." In August, however, he writes: "As far as laboratories and lecture rooms are concerned, I believe we have little to learn either in England or Paris." And on his return: "We in this country have a great deal to learn in the arrangement of museums of practical art and science, and much also to learn in regard to the auxiliaries of practical art education. Yet our educational system is in many particulars abreast of the Old World schools, and in the elementary principles decidedly in advance of them. Looking to scientific education and methods of instruction, there is such vitality, quickness of observation and ready, flexible application belonging to our countrymen, that we have already embraced some of the most important ideas introduced in Europe. What is wanted is for American students to give time enough to secure thoroughness in the study of applied sciences. . . . The Polytechnic Institute of Carlsruhe, which is regarded as the model school of Germany, and perhaps of Europe, is nearer what it is intended the Massachusetts Institute of Technology shall be than any other foreign institution."

At last in February, 1865, after all these years of preparation, the school is actually opened, with twenty-seven students, in modest, rented quarters on Summer Street, pending the completion of the stately building on Boylston Street, long since named for President Rogers. This preliminary session made it possible to have both first and second year classes in the fall term. "The studies and exercises of the School are so organized as to provide a complete course of instruction and training, suited to the various practical professions of the Mechanician, the Civil Engineer, the Builder and Architect, the Mining Engineer and the Practical Chemist; and, at the same time, to meet the more limited aims of such as desire to secure a scientific preparation for special industrial pursuits, — such as the Direction of Mills, Machine Shops, Railroads, Mines, Chemical Works, Glass, Pottery and Paper Manufactures, and of Dyeing Print and Gas Works; and for the practice of Navigation and Surveying, of Telegraphy, Photography and Electrotyping, and the various other Arts having their foundation in the exact sciences.

"The Courses of Instruction, while thus providing for the scientific study of the Constructive and Manufacturing Arts, offer a variety of general as well as special studies, which may be advantageously followed by students preparing for commercial occupations, and they present to such as are desirous of becoming teachers of science in our schools and other institutions the opportunity of equipping themselves for this profession, by practice in manipulations, as well

(*Continued on page 152*)

This shows the new greatly improved Hercules Blasting Machine.



The inside workings of the Hercules Blasting Machine.

An Improved Blasting Machine

The new Hercules Blasting Machine was developed during the war after the United States Army Ordnance Department found that the machines formerly used did not meet the severe and exacting requirements of military service. This improved machine is more reliable and, in extensive use, has already proved its superiority over the types formerly used for industrial work.

In the old model, much of the energy of the operator is consumed uselessly in the machine itself, and the small current that enters the cap circuit is of very short duration. In our new machine, the blasting circuit is closed at the instant of maximum voltage and amperage, and the current is maintained in the circuit for an appreciable period. Besides delivering a greater current at a higher voltage, the new Hercules machine sustains this current longer.

Because of the superiority of its generator, the new Hercules Blasting Machine, which weighs less than the old machines rated to fire thirty caps, has fired up to two hundred electric blasting caps, connected in series. However, we rate the capacity of this machine at fifty caps, because we do not recommend connecting more than fifty electric blasting caps in one series under working conditions.

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THE FOUNDERS OF THE INSTITUTE

(*Continued from page 150*)

as by an ample course of scientific studies."

The teachers, besides the President, included Runkle in mathematics, Storer in chemistry, Watson and Carlton in drawing, Bôcher in French. In June of 1865, Rogers secured Eliot as an additional professor of chemistry, the latter writing from Vienna: "Nothing has struck me more in Europe than the great and prompt success which all the well-organized Polytechnic Schools have had, — Paris, Carlsruhe, Stuttgart, Zürich, Vienna, — all illustrate the wonderfully rapid growth and wide usefulness of these technical schools. Looking at such schools, I have often felt how useful would be the work in which you have been engaged these several years in Boston, provided only that the community gave you an adequate support. What governments do in Europe individuals must do with us, and ours is infinitely the best way in the long run."

Rogers' modernness of view is well illustrated in a letter of April 1867: "The intellectual and æsthetic discipline obtained in the study of languages, modern as well as ancient, is of undoubted value, and ought to be provided for in every comprehensive course of education. But this training can in no degree replace the invigorating exercise of the observing and logical faculties so peculiarly the function of scientific studies. Let the classics have their place among the instruments of intellectual culture, but in a general education let them be kept within the modest limits appropriate to them, in which they shall not, as they now so often do, stand in the way of the broader, higher and more practical instruction and discipline of the natural and social sciences."

It seemed at times that the indomitable faith of President and Mrs. Rogers had attempted to remove mountains too massive for their resources. Enthusiasm was more abundant than dollars, which beyond a certain point it could not replace. Advancing years were inexorably telling on President Rogers' none too robust physique and in 1868 his health failed in the midst of a meeting of his Faculty. The leadership of the feeble school, not yet out of its infancy, was transferred to Professor Runkle as Rogers' trusted lieutenant.

The next ten years were a period of many and grievous vicissitudes for the Institute, of very gradual restoration to some measure of health and strength to its founder. In 1878 President Runkle laid down the burden and Rogers writes: "I have agreed, at the solicitation of the Corporation, to take charge of our noble ship in a general way and with lightened duties until another President is appointed, on the condition that the Corporation shall raise $100,000 to be added to our fund by the beginning of the next school year." Most fortunately he was spared long enough not only to find an admirable successor in General Walker but in the very hour of death, at the graduation exercises of 1882, to make public transfer of the trust of so many anxious yet happy years to President Walker.

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SHOP LIGHTING.

In an address delivered before the members of the Western Pennsylvania Division of the National Safety Council, Pittsburg, Pa., March, 1918, by C. W. Price, the importance of good lighting in industrial establishments was discussed, and the disadvantages of poor lighting were clearly shown by some figures mentioned by Mr. Price.

A large insurance company analyzed 91,000 accident reports, for the purpose of discovering the causes of these mishaps. It was found that 10% was directly traceable to inadequate lighting and in 13.8% the same cause was a contributory factor. The British Government in a report of the investigation of causes of accidents determined a close parallel to the findings of the insurance company above quoted. The British investigators found that by comparing the four winter months with the four summer months, there were 39.5% more men injured by stumbling and falling in winter than in summer.

Mr. John Calder, a pioneer in safety work, made an investigation of accident statistics covering 80,000 industrial plants. His analysis covered 700 accidental deaths, and of these 45% more occurred during the four winter months than during the four summer months.

Mr. C. L. Eschleman, in a paper published in the proceedings of the American Institute of Electrical Engineers several years ago, reported the result of an investigation of a large number of plants in which efficient lighting had been installed. He found that in such plants as steel mills, where the work is of a coarse nature, efficient lighting increased the total output 2%; in plants, such as textile mills and shoe factories, the output was increased 10%.

In an investigation of the causes of eye fatigue, made by the Industrial Commission of Wisconsin, it was found that in a large percentage of industries, such as shoe, clothing and textile factories, the lack of proper lighting (both natural and artificial) resulted in eye fatigue and loss of efficiency. At one knitting mill, where a girl was doing close work under improper lighting conditions, her efficiency dropped 50% every day during the hours from 2:30 to 5:30 P. M.

The above mentioned incidents indicate how important a factor lighting is in the operation of the industrial plant. It has been well said, "Light is a tool, which increases the efficiency of every tool in the plant." Glare or too much light is as harmful as not enough lighting, and in no case should the eyes of the workers be exposed to direct rays, either of sun or electric light.

Windows and reflectors should always be kept clean; that is, cleaning them at least once a week, for where dust and dirt are allowed to collect, efficiency of the light is decreased as much as 25%.

Good lighting, in addition to its other marked advantages, is a strong incentive towards keeping working places clean, for it clearly exposes any place where dirt or other material has been allowed to collect. White walls and clean windows glazed with Factrolite Glass will eliminate the sun glare and increase the illumination 25 to 50 feet from the window from 38% to 72% as compared with plain glass.

Lighting is of primary importance to every employer and fully warrants a careful investigation of the subject, for there is no substitute for good lighting, and if it is not supplied the efficiency of the entire working force must suffer a serious reduction.

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B·S

THE DEGLARESCOPE

(*Continued from page 128*)

because of the possible elimination of glare by the Deglarescope and because of a somewhat larger than normal loss of light in the Deglarescope it would be wise, legally, to allow a user to employ a higher candle-power headlight lamp in the Deglarescope than is permitted by the present Massachusetts specifications, for example. In fact the State of California permits the use of thirty-two candle-power lamps in the Deglarescope.

The Deglarescope is a plane glass window built up of thin strips of glass cemented together, as shown in Figure 1. The faces of this composite window are polished, and very fine vertical flutings are ground into the back face to give the desired side spread to the headlight beam.

Figure 2 shows how the total reflecting upper face of the element or strip throws light downwards on the road a short distance ahead of the machine, and how the absorbing lower face of the element or strip cuts off light which would otherwise be thrown upwards.

Figure 3 shows how the major part of the approximately parallel beam

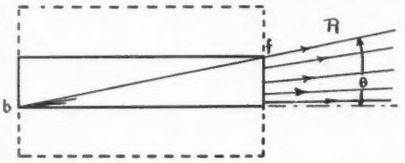

FIGURE 4

from lamp and parabolic reflector passes through the composite window of the Deglarescope.

Figure 4 shows how a sharp cut-off of light from the region "R" (at a distance from the headlight) is realized in the Deglarescope. The lower back edge "b" and the upper front edge "f" of an element or strip determine the angle "O," above which there is no light in the headlight beam.

The lower faces of the elements or strips of the composite window of the Deglarescope can be made only partially absorbing to give a desired amount of light in the region "R," or some of the strips can be turned upside down or made totally reflecting on both faces to accomplish the same result.

The fine vertical flutings on the back face of the composite window of the Deglarescope are not shown in any of the figures. If these flutings are very fine, a very small amount of material, only, need be removed in making the flutings; and a very ingenious method has been devised for making these flutings as follows: the composite window is first ground and polished flat on both faces. The window is then fed slowly under a revolving soft metal cylinder which is encircled by very fine corrugations. These fine corrugations are kept intact by means of a hard steel cylinder which is pressed against the back of the soft metal cylinder so that fine encircling corrugations on the steel cylinder press into the soft metal cylinder, and a stream of water or oil and rouge is fed onto the apparatus so as to cut out the fine flutings in the face of the composite window.

GRAVEL ROAD MAINTENANCE

(*Continued from page 133*)

is medium or possibly average, considering all of the gravel roads, one man can care for at least twenty miles if provided with the proper equipment and materials.

A summary of the most important features in connection with proper road maintenance and the items that should be particularly exacted under governing specifications is as follows:

1. Good drainage.
2. Proper shaping of the road surface with not over a four-inch crown.
3. Application of clean small pebbles in thin layers.
4. Dragging often, depending on the amount of use.
5. Prompt attention to development of defects.

Neglecting to provide for or perform any of the above mentioned important features in connection with grave road maintenance will result in failure.

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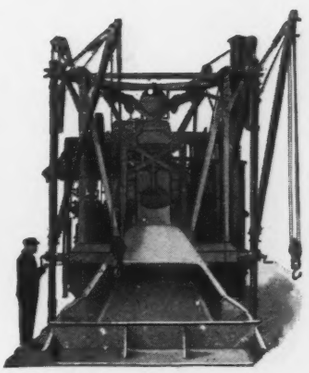

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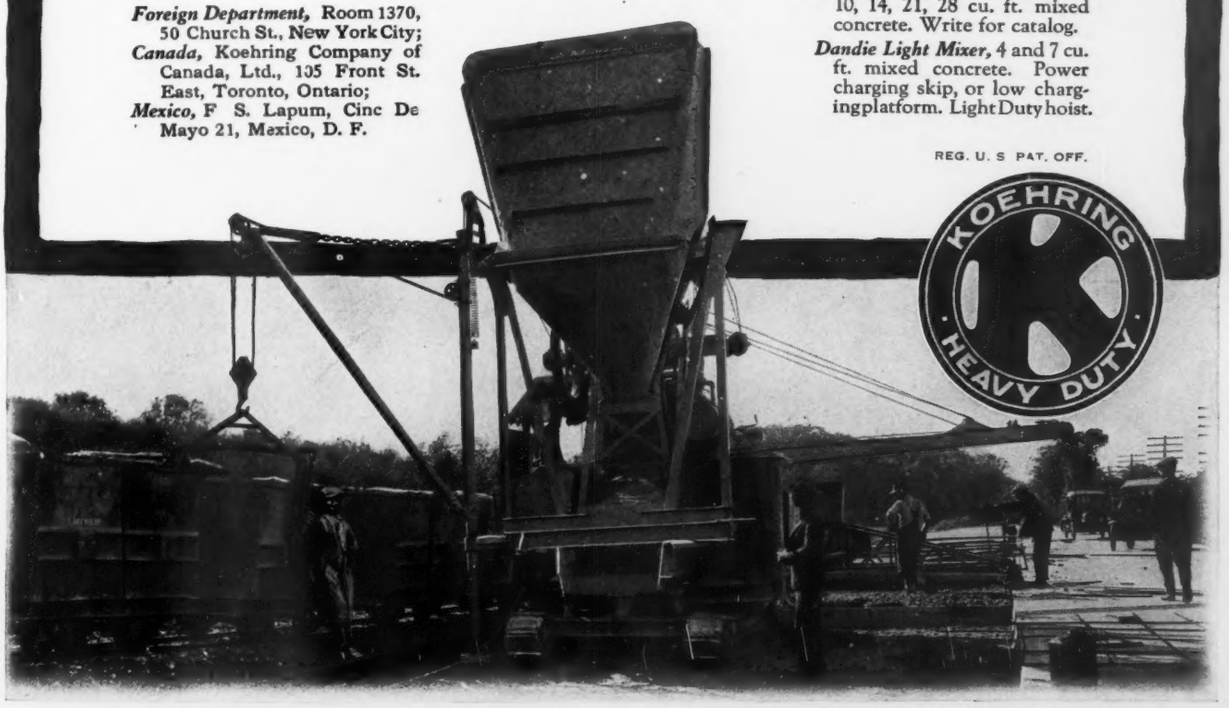

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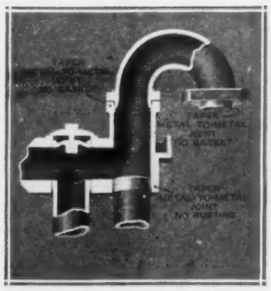

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